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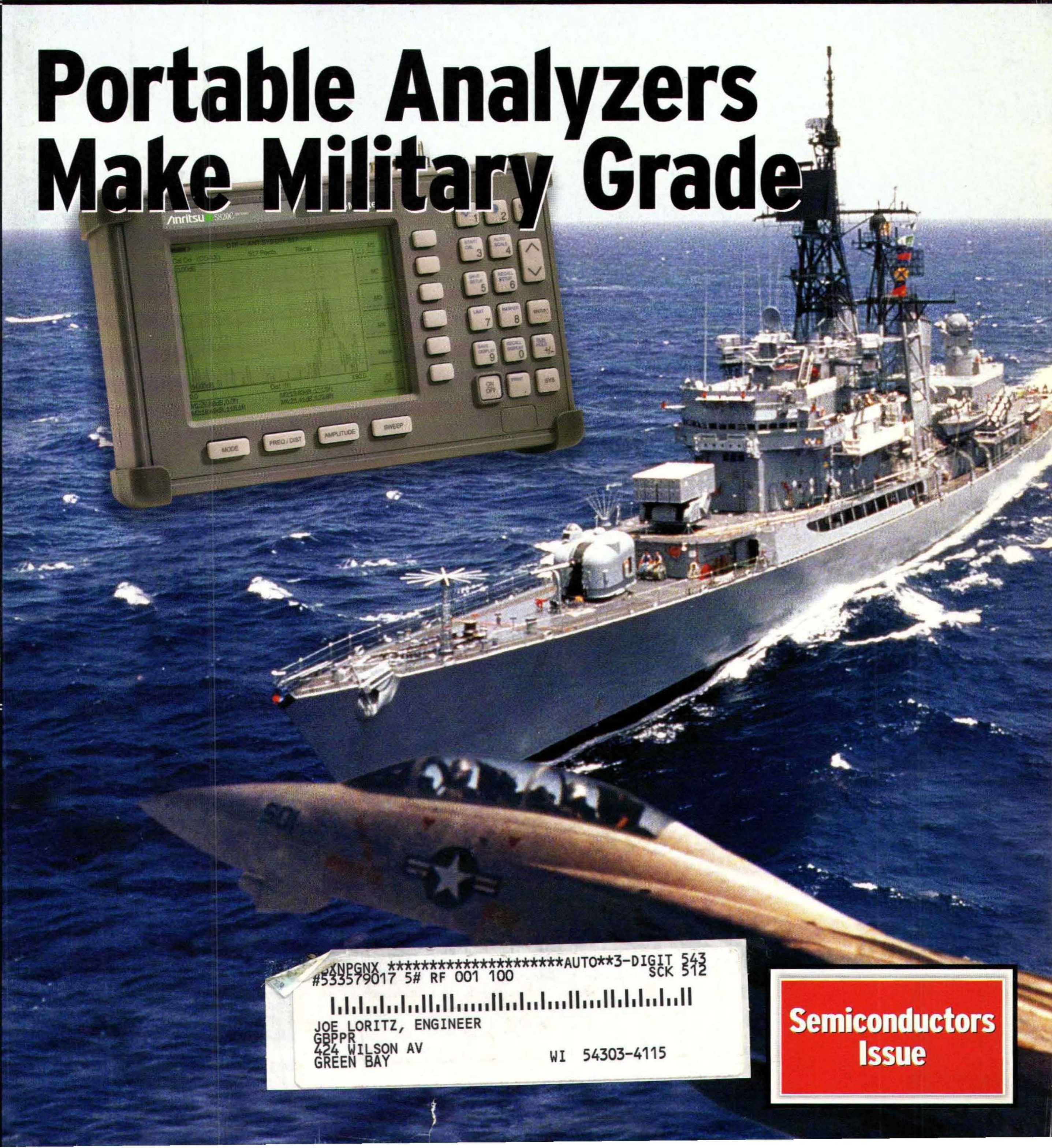
Microwaves & RF

News
Reviewing advances in DSPs and data converters

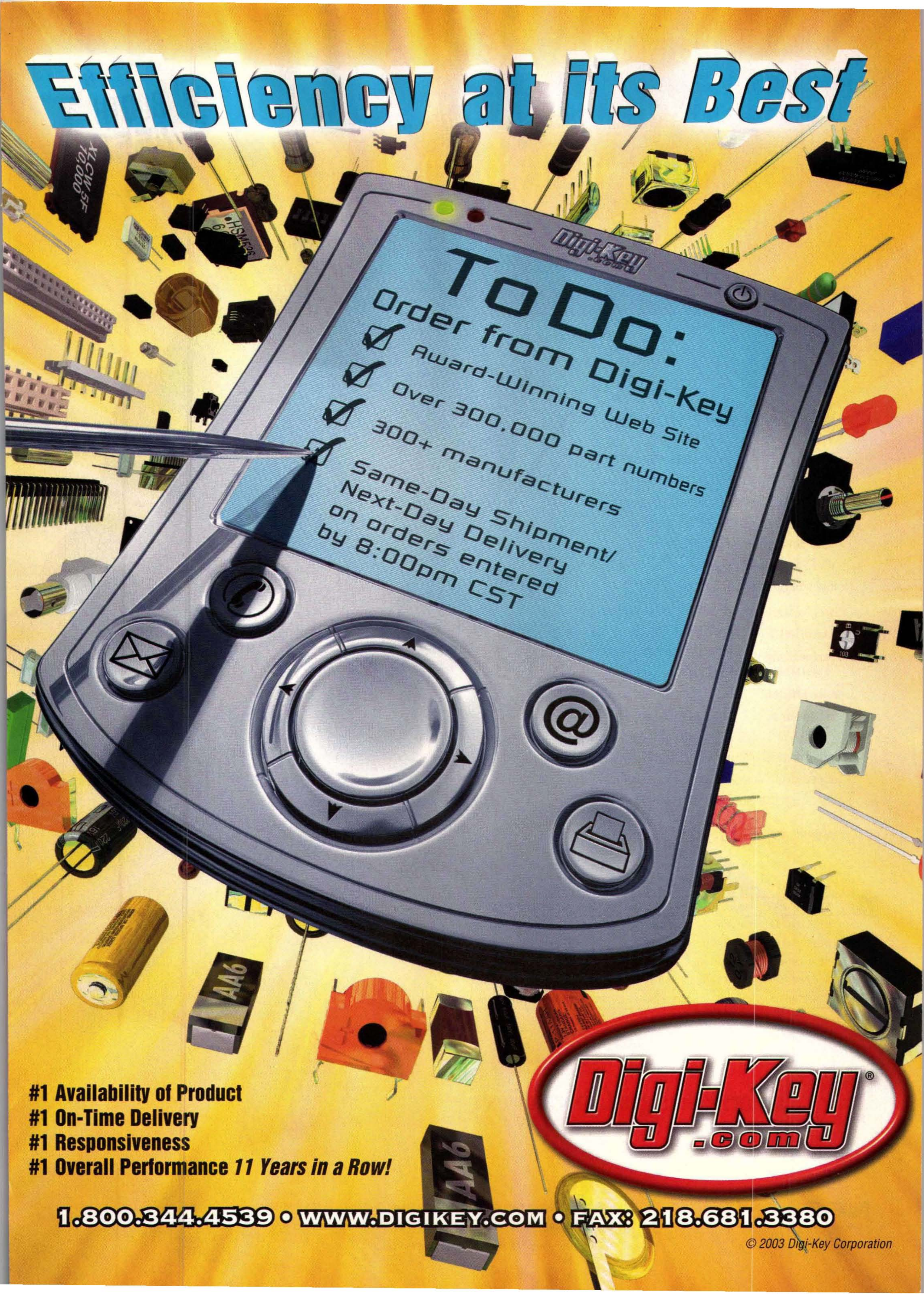
Design Feature
Comparing microwave control devices

Product Technology
MMIC mixers reach high intercept points

Portable Analyzers Make Military Grade



Semiconductors Issue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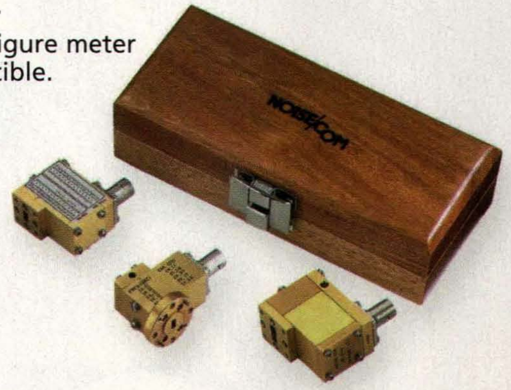

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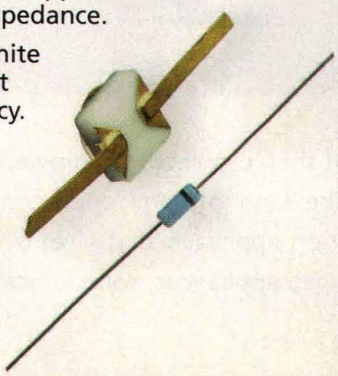

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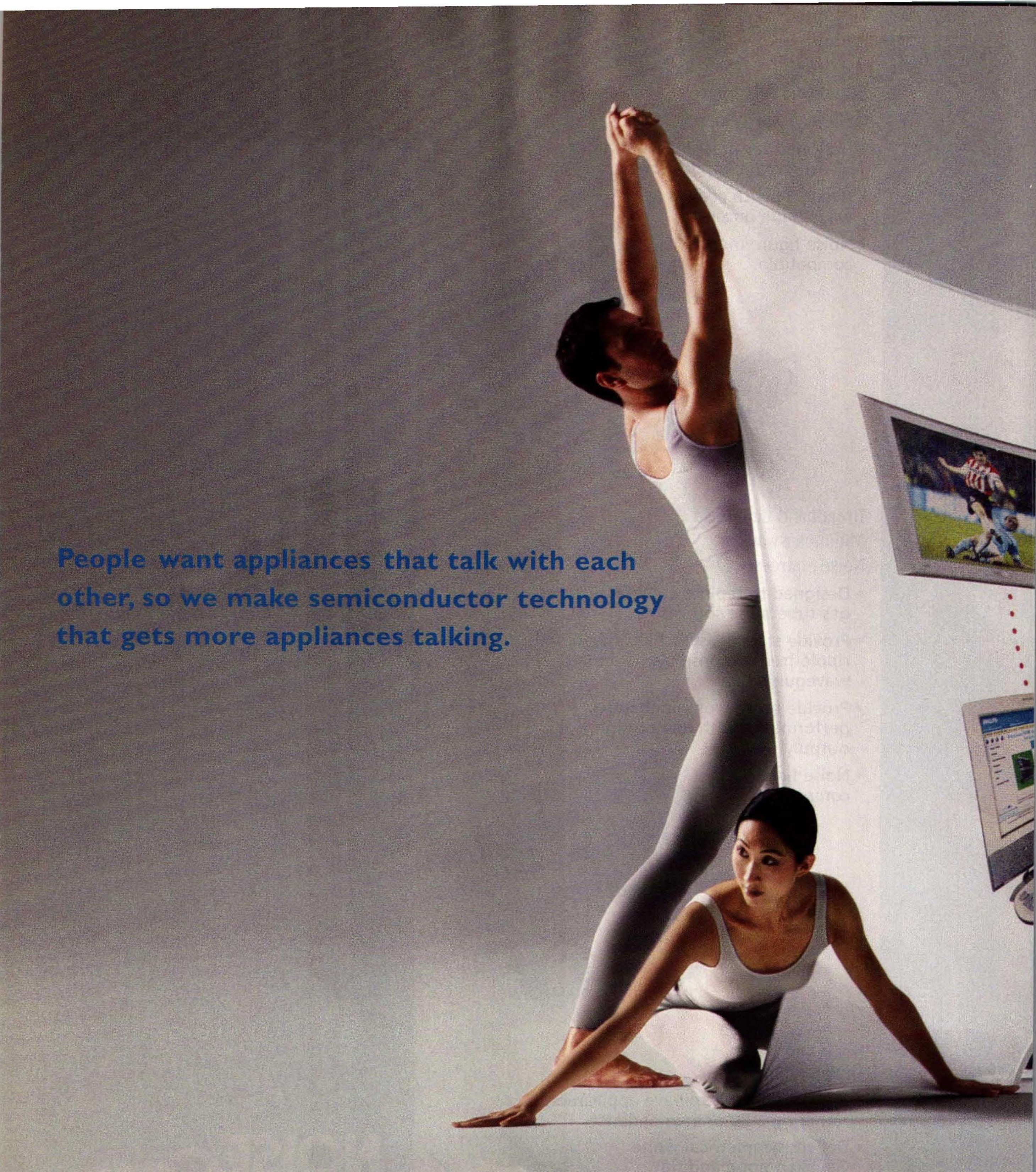

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New RF Ideas Are Needed

Editor's Note: The first part of this letter was published in the Feedback section in the February 2003 issue of Microwaves & RF *(p. 13). In that first part, Mr. Alechno discussed the pessimism in the RF industry and the need for advanced forums for industry tutorials and discussion.*

▶▶WIDELY CIRCULATED print publications like *Microwaves & RF* and other types of wide communication are almost out of function. As is well known, journals such as *Microwaves & RF* must keep some relation of ads/arts and in lean times such as those we are currently experiencing, the space is strictly limited. For example, I have waited some three years lately to have some of my work published. I have in stock papers written just with the attitude sketched above. One of these papers concerns amplifier-stability factors and is still awaiting publication in another magazine two years after it was accepted. I do not know what I'm going to do with my last paper, on PLL basics.

I am coming to the conclusion that a new form of instant publishing is needed for the microwave and RF industry, something intermediate between the two that I have considered in this letter. It could be called Internet Microwaves & RF Archives, and, as the name suggests, could be organized by *Microwaves & RF* magazine. This would be the means for instant online publishing for every article and shorter communication sent to the magazine and initially reviewed. *Microwaves & RF* could take the articles and shorter pieces that have been downloaded most often, edit them as per magazine specifications, and run the edited versions in the print edition of the magazine. For *Microwaves & RF*, it would be an opportunity to increase the popularity of its website, as well as furthering the profile of the print publication. Furthermore, their Web forum, now fading, could be used for discussion of archives content.

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alechno@wa.onet.pl

PLEASE COMMENT

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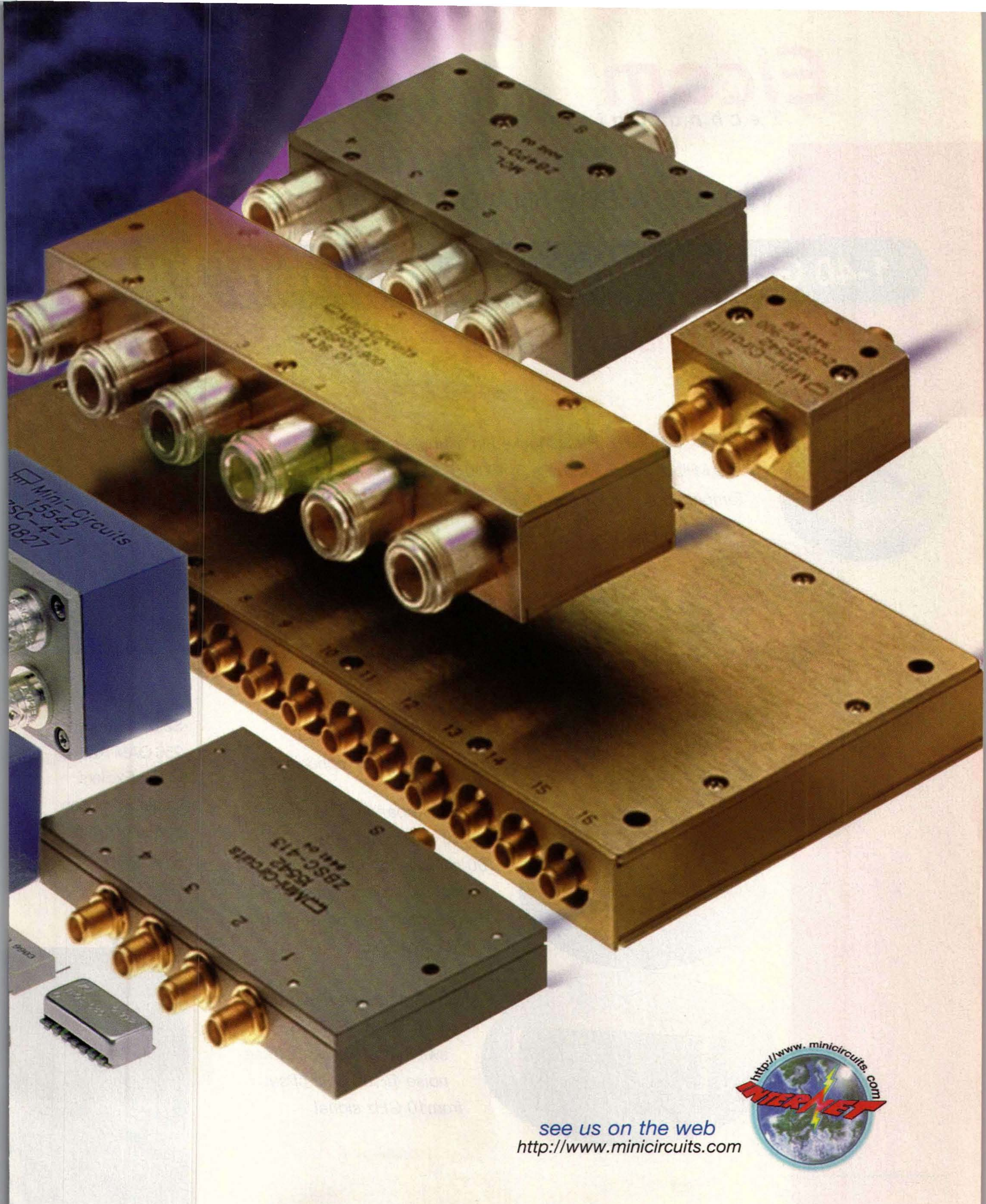

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Sometimes, It's Just Stubbornness

SURVIVAL IN BUSINESS OFTEN requires fortitude and vision, and generally a determination to outlast one's competition. Sometimes, survival is simply a matter of being too stubborn to give up on an idea or a conviction. In the current challenging economic environment, some lessons in stubbornness might serve as inspiration for engineers striving for creativity while witnessing cutbacks in budgets, in staffing, and in support.

Sometimes, survival is simply a matter of being too stubborn to give up on an idea or conviction.

One of the more inspirational speakers in this industry, Doug Lockie, executive vice-president and founder of Endwave Corp. (Sunnyvale, CA, www.endwave.com), chaired a session on Broadband Wireless strategies and technologies at the recent Wireless Systems Design Conference & Expo. Doug has long been fascinated with millimeter-wave technology, in spite of its military association and its reputation for being expensive.

Doug's faith in the future of millimeter-wave technology is infectious, and his many contacts within the industry helped him to assembly one of the better-attended technical sessions at the Wireless Systems Design Conference & Expo. Included in those sessions was a presentation of particular note by Dave Stephenson, engineering manager for Bridge Products at Cisco Systems (San Jose, CA, www.cisco.com), who spoke of the tremendous potential for connecting the computer networks of more than 700,000 business buildings by means of millimeter-wave Gigabit class radios (currently, only about 8000 buildings are connected, by optical fiber). The presentation brought a measure of increased credibility to millimeter-wave techniques, with Cisco's obvious interest in the technology.

Another story of stubbornness/perseverance emerged from the humble but ingenious Dr. Richard Ruby, director of technology for the Wireless Semiconductor Division of Agilent Technologies (Newark, CA). His belief that high-frequency filters could be accomplished by means of processing acoustic waves was initially dismissed in the early 1990s by the company's (at that time Hewlett-Packard Co.) management as too impractical. Undaunted, he stuck to his beliefs in the approach, making his own investments in equipment and time for several years until finally fabricating some filters that made management take notice. Ironically, that technology—film bulk acoustic resonator (FBAR)—has accounted for shipments of more than 10 million cellular duplexers since the FBAR products were introduced in 2001.

Certainly, there are many more stories like these. They are good examples that great ideas are not always recognized at first, but that sometimes stubbornness can eventually lead to success.

Jack Browne

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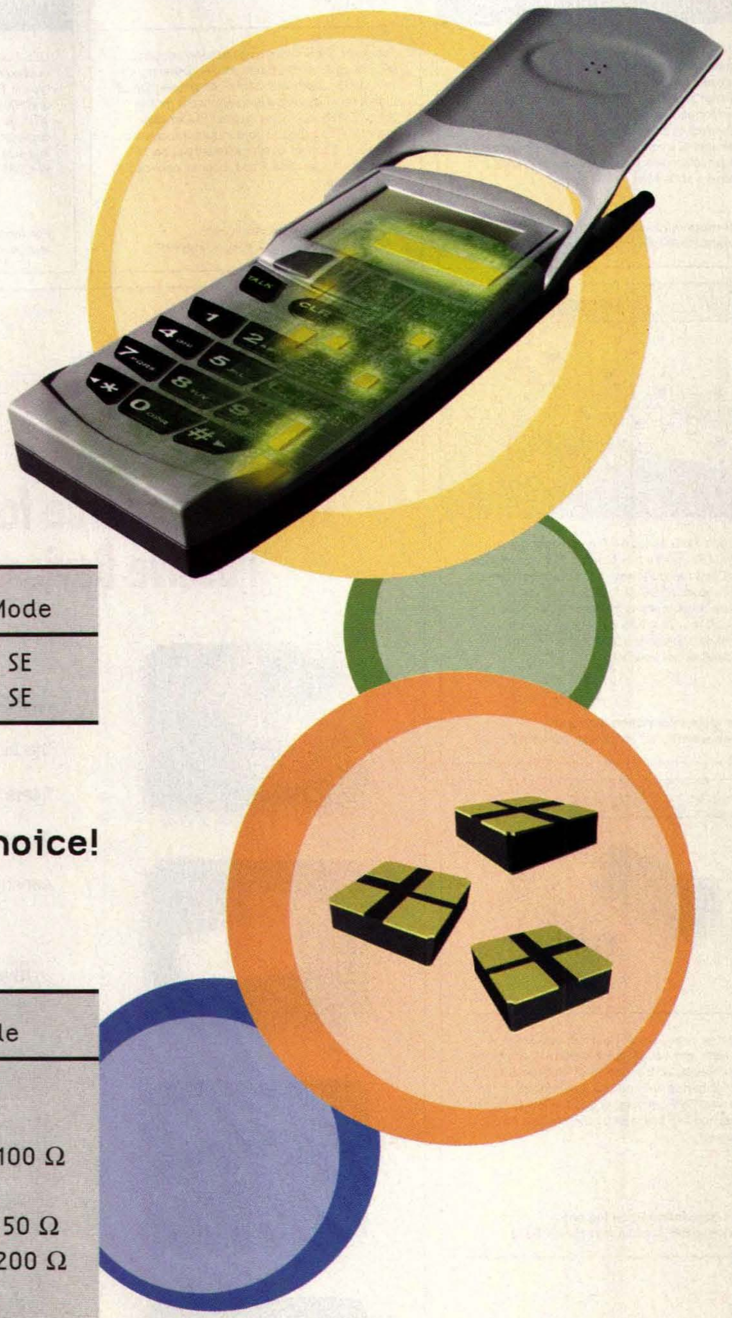

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881.5	Cellular Rx	SE/BAL 100 Ω
942.5	EGSM Rx	SE
942.5	EGSM Rx	SE/BAL 50 Ω
942.5	EGSM Rx	SE/BAL 200 Ω
1575.0	GPS Rx	SE
1575.0	GPS Rx	SE/BAL 100 Ω
1765.0	KPCS Tx	SE
1842.5	DCS Rx	SE/BAL 50 Ω
1842.5	DCS Rx	SE/BAL 200 Ω
1855.0	KPCS Rx	SE
1855.0	KPCS Rx	SE/BAL 100 Ω
1880.0	U.S. PCS Tx	SE
1960.0	U.S. PCS Rx	SE
1960.0	U.S. PCS Rx	SE/BAL 100 Ω
1960.0	U.S. PCS Rx	SE/BAL 200 Ω

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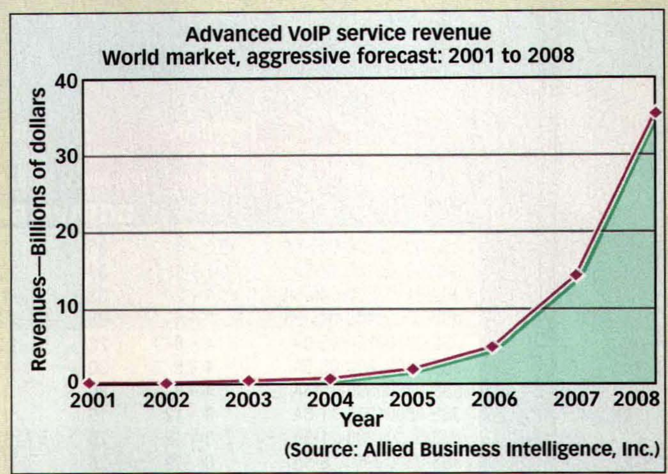
the front end

News items from the communications arena.

Market For Hosted VoIP Services To Reach $36.5 Billion In 2008

OYSTER BAY, NY—Telecom carriers have been offering hosted voice services, like IP Centrex, based on circuit-switched gear, for years. Markets for such services have remained steady, but small due to limited feature sets and geographical dependence on the local central office (CO). Offering services based on next-generation Internet-protocol (IP) voice technology removes a number of these limitations, and typical architectures are inherently well suited to the hosted model due to their distributed nature.



While general availability of many IP voice offers to date have been limited, the combined worldwide revenues for hosted VoIP services, including IP-PBX, videoconferencing, contact center, and unified communications are expected to grow from $46 million in 2001 to $36.5 billion in 2008 **(see figure)**, according to the findings in a report from Allied Business Intelligence, Inc. (ABI).

ABI's report, "Advanced IP Voice Services, Market Forecasts and Trends for VoIP-based Services: IP-PBX, Videoconferencing, Contact Center and Unified Communications," examines the types of advanced VoIP services that are emerging, and the profiles of customers who are adopting them. The report provides an overview of vendor offerings, with analysis of market trends and forecasts. Services addressed include IP-PBX, conferencing, contact centers, and unified communications.

Ansoft Corp.'s Dr. Zoltan Cendes Is Elected IEEE Fellow

PITTSBURGH, PA—Ansoft Corp. announced that Dr. Zoltan Cendes, the company's founder, chairman, and chief technology officer, was recently elected an Institute of Electrical and Electronics Engineers (IEEE) Fellow for his outstanding contributions to the application of finite-element modeling to microwave guides, structures, and circuits.

Dr. Cendes was the first microwave engineer to develop the finite-element technique using edge elements in the solution of the vector-wave equation. His early accomplishments led to the development of HFSS™, the industry-standard high-frequency tool for 3D electromagnetic-based design.

"It's wonderful to see this honor bestowed upon Zol," said Nick Csendes, Ansoft's president and CEO. "His dedication to finite-element analysis has made him a pioneer in the field of high-frequency electromagnetics; and his commitment, technical expertise, and visionary outlook over the years have made Ansoft the leader it is today."

Dr. Cendes has been responsible for Ansoft's product and technology research and for the overall direction of the company's software since he founded the corporation in 1984. In addition to his responsibilities at Ansoft, Dr. Cendes is also an adjunct professor of electrical and computer engineering at Carnegie Mellon University in Pittsburgh, where he served as both an associate professor and professor for 14 years. He received his master's and doctoral degrees in Electrical Engineering from McGill University in Montreal, Canada.

Ultra-Low Noise AMPLIFIERS

VHF To V-BAND

MODEL NUMBER	FREQUENCY RANGE (GHz)	GAIN (dB, Min.)	GAIN VARIATION (±dB, Max.)	NOISE FIGURE (dB, Max.)	VSWR IN	VSWR OUT	POWER OUT @ 1 dB COMP. (dBm, Min.)	DC POWER @ +15 V (mA, Nom.)
OCTAVE BAND AMPLIFIERS								
JS2-00500100-045-5A	0.5 – 1	35	1	0.45	2:1	2:1	5	250
JS2-00500100-12-5A	0.5 – 1	35	1.2	1	2:1	2:1	5	250
JS2-01000200-045-5A	1 – 2	33	1	0.45	2:1	2:1	5	250
JS2-02000400-045-5A	2 – 4	28	1.2	0.45	2:1	2:1	5	175
JS2-04000800-08-0A	4 – 8	22	1.2	0.8	2:1	2:1	0	150
JS3-04000800-08-5A	4 – 8	30	1	0.8	2:1	2:1	5	175
JS3-04000800-15-5A	4 – 8	30	1	1.5	2:1	2:1	5	175
JS2-08001200-11-5A	8 – 12	15	1	1.1	2:1	2:1	5	150
JS3-08001200-11-5A	8 – 12	25	1	1.1	2:1	2:1	5	175
JS3-08001200-15-5A	8 – 12	25	1	1.5	2:1	2:1	5	175
JS3-12001800-16-5A	12 – 18	23	1	1.6	2:1	2:1	5	175
JS4-12001800-145-5A	12 – 18	30	1	1.45	2:1	2:1	5	200
JS4-12001800-30-5A	12 – 18	30	1	3	2:1	2:1	5	200
JS2-18002600-20-5A	18 – 26	14	2	2	2.5:1	2.5:1	5	100
JS2-18002600-30-5A	18 – 26	14	2	3	2.5:1	2.5:1	5	100
JS3-18002600-20-5A	18 – 26	22	1.8	2	2.5:1	2.5:1	5	175
JS3-18002600-30-5A	18 – 26	22	1.8	3	2.5:1	2.5:1	5	175
JS4-18002600-19-5A	18 – 26	33	1.5	1.9	2:1	2:1	5	200
JS4-18002600-26-5A	18 – 26	33	1.5	2.6	2:1	2:1	5	200
JS2-26004000-35-5A	26 – 40	10	2	3.5	2.5:1	2.5:1	5	100
JS2-26004000-45-5A	26 – 40	10	2	4.5	2.5:1	2.5:1	5	100
JS3-26004000-35-5A	26 – 40	18	2.5	3.5	2.5:1	2.5:1	5	175
JS3-26004000-45-5A	26 – 40	18	2.5	4.5	2.5:1	2.5:1	5	175
JS4-26004000-40-5A	26 – 40	23	2.5	4	2:1	2:1	5	200
JS4-40006000-65-0A	40 – 60	15	3	6.5	2.75:1	2.75:1	0	175
MULTIOCTAVE BAND AMPLIFIERS								
JS2-00500200-07-5A	0.5 – 2	32	1	0.7	2:1	2:1	5	295
JS2-00500200-15-5A	0.5 – 2	32	1	1.5	2:1	2:1	5	295
JS2-01000400-08-5A	1 – 4	27	1	0.8	2:1	2:1	5	200
JS2-01000400-20-5A	1 – 4	27	1	2	2:1	2:1	5	200
JS2-02000600-08-5A	2 – 6	22	1	0.8	2:1	2:1	5	125
JS2-02000600-20-5A	2 – 6	22	1	2	2:1	2:1	5	125
JS2-02000800-08-0A	2 – 8	22	1.25	0.8	2:1	2:1	0	125
JS2-02000800-20-0A	2 – 8	18	1.25	2	2:1	2:1	0	125
JS3-02001800-25-5A	2 – 18	23	1.8	2.5	2.5:1	2.5:1	5	150
JS3-02001800-50-5A	2 – 18	23	1.8	5	2.5:1	2.5:1	5	150
JS4-02001800-22-5A	2 – 18	30	2	2.2	2.5:1	2.5:1	5	200
JS4-02001800-50-5A	2 – 18	30	2	5	2.5:1	2.5:1	5	200
JS3-02002600-33-5A	2 – 26	21	2.5	3.3	2.5:1	2.5:1	5	150
JS3-02002600-40-5A	2 – 26	21	2.5	4	2.5:1	2.5:1	5	150
JS3-06001800-16-5A	6 – 18	23	1.8	1.6	2:1	2:1	5	125
JS3-06001800-30-5A	6 – 18	23	1.8	3	2:1	2:1	5	125
JS4-06001800-145-5A	6 – 18	31	2	1.45	2:1	2:1	5	200
JS4-06001800-30-5A	6 – 18	31	2	3	2:1	2:1	5	200

MITEQ's JS SERIES AMPLIFIERS

- High Performance/Price Ratio
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Actual
18 to 40 GHz Design

MODEL NUMBER	FREQUENCY RANGE (GHz)	GAIN (dB, Min.)	GAIN VARIATION (±dB, Max.)	NOISE FIGURE (dB, Max.)	VSWR IN	VSWR OUT	POWER OUT @ 1 dB COMP. (dBm, Min.)	DC POWER @ +15 V (mA, Nom.)
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JS3-08001800-16-5A	8 – 18	24	1.5	1.6	2:1	2:1	5	150
JS3-08001800-30-5A	8 – 18	24	1.5	3	2:1	2:1	5	150
JS4-08001800-145-5A	8 – 18	32	2	1.45	2:1	2:1	5	200
JS4-08001800-30-5A	8 – 18	32	2	3	2:1	2:1	5	200
JS3-12002600-25-5A	12 – 26	22	2.5	2.5	2.2:1	2.2:1	5	150
JS3-12002600-35-5A	12 – 26	22	2.5	3.5	2.2:1	2.2:1	5	150
JS4-12002600-22-5A	12 – 26	32	2.2	2.2	2:1	2:1	5	200
JS4-12002600-35-5A	12 – 26	32	2.2	3.5	2:1	2:1	5	200
JS3-18004000-38-5A	18 – 40	16	2.5	3.8	2.5:1	2.5:1	5	150
JS3-18004000-50-5A	18 – 40	16	2.5	5	2.5:1	2.5:1	5	150
JS4-18004000-30-5A	18 – 40	23	2.5	3	2.5:1	2.5:1	5	200
JS4-18004000-50-5A	18 – 40	23	2.5	5	2.5:1	2.5:1	5	200
ULTRAWIDE BAND AMPLIFIERS								
JS2-00100200-07-5A	0.1 – 2	32	1	0.7	2:1	2:1	5	295
JS2-00100200-15-5A	0.1 – 2	32	1	1.5	2:1	2:1	5	295
JS2-00100400-08-5A	0.1 – 4	27	1	0.8	2:1	2:1	5	200
JS2-00100400-12-5A	0.1 – 4	27	1	1.2	2:1	2:1	5	200
JS2-00100600-10-3A	0.1 – 6	23	1.5	1	2:1	2:1	3	175
JS2-00100600-20-3A	0.1 – 6	23	1.5	2	2:1	2:1	3	175
JS2-00100800-13-0A	0.1 – 8	20	1.5	1.3	2:1	2:1	0	175
JS2-00100800-25-0A	0.1 – 8	20	1.5	2.5	2:1	2:1	0	175
JS3-00101000-20-5A	0.1 – 10	23	1.5	2.0	2.5:1	2:1	5	150
JS3-00101000-35-5A	0.1 – 10	23	1.5	3.5	2.5:1	2:1	5	150
JS3-00101200-21-5A	0.1 – 12	23	1.5	2.1	2.5:1	2:1	5	150
JS3-00101200-35-5A	0.1 – 12	23	1.5	3.5	2.5:1	2:1	5	150
JS3-00101800-24-5A	0.1 – 18	23	1.8	2.4	2.5:1	2.2:1	5	150
JS3-00101800-40-5A	0.1 – 18	23	1.8	4	2.5:1	2.2:1	5	150
JS4-00101800-23-5A	0.1 – 18	29	1.8	2.3	2.5:1	2.2:1	5	200
JS4-00101800-40-5A	0.1 – 18	29	1.8	4	2.5:1	2.2:1	5	200
JS4-00102000-25-5A	0.1 – 20	28	1.8	2.5	2.5:1	2.5:1	5	200
JS4-00102000-35-5A	0.1 – 20	28	1.8	3.5	2.5:1	2.5:1	5	200
JS3-00102600-33-5A	0.1 – 26	20	2.5	3.3	2.5:1	2.5:1	5	150
JS3-00102600-42-5A	0.1 – 26	20	2.5	4.2	2.5:1	2.5:1	5	150
JS4-00102600-28-5A	0.1 – 26	27	2.5	2.8	2.5:1	2.5:1	5	200
JS4-00102600-50-5A	0.1 – 26	27	2.5	5	2.5:1	2.5:1	5	200
JS4-00104000-65-5A	0.1 – 40	14	4.5	6.5	2.75:1	2.75:1	5	200
JS4-00104000-85-5A	0.1 – 40	14	4.5	8.5	2.75:1	2.75:1	5	200

For additional information or technical support, please contact either Rosalie DeSousa at (631) 439-9458, e-mail rdesousa@miteq.com or Rizwan Syed at (631) 439-9267, e-mail rsyed@miteq.com

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Contract For $2.3M Is Signed To Support Satellite System

NORTHAMPTON, MA—Millitech, LLC has received a phase-two contract for $2.3 million from Boeing Satellite Systems to supply millimeter-wave receivers (Rxs) in support of the Conical Microwave Image Sounder (CMIS) program. The CMIS contract includes up to 12 years of options, which could double the value of the order, to supply flight hardware for the National Polar-Orbiting Operational Environmental Satellite System (NPOESS).

NPOESS is the next-generation, low-earth-orbit environmental satellite system that will save the US Government approximately $1.8 billion by converging existing systems operated by the Department of Defense (DoD) and the National Oceanic Atmospheric Administration (NOAA). CMIS is one of the weather instruments included on six NPOESS satellites. The first CMIS instrument is scheduled for delivery by 2005 with the second to be delivered by 2007. The first NPOESS satellite is scheduled to be available for launch in 2009.

"This continues Millitech's 20-year history of supporting flight hardware for satellite applications," said Bill Hanley, president and CEO of Millitech, LLC. "We are very excited to contribute to the state-of-the-art technology that will be launched on the CMIS program. This award complements our diverse base of microwave and millimeter-wave work that includes radar, satellite communications, environmental sensing, and remote space-based sensing."

The CMIS sensor consists of three different subsystems: antennas, receivers, and data handling. The antennas gather microwave energy from the earth's geological landscape. The receivers divide the microwaves into numerous specific channels and measure the "brightness" of the earth within each channel. The data-handling subsystem formats the sensor data and other critical information for transmission to the ground where algorithms turn the data into weather information such as maps of ocean temperature, wind speed, and snow cover.

The initial funding for this system was a $750,000 proof-of-concept and design effort that was successfully completed last year by the company's engineering group at the corporate headquarters in Northampton, MA. The further development and manufacturing of the system will be done at the same facility.

Ottawa Fire Dept. Improves Radio Communications

LOWELL, MA—M/A-COM, Inc., a unit of Tyco Electronics and manufacturer of critical radio systems deployed around the world, was awarded a $2.75 million (US) contract from the City of Ottawa (Canada) to implement the Fire Department's new Console Dispatch System and to purchase new radios. These new units will be added to the existing City of Ottawa-owned 800-MHz EDACS (Enhanced Digital Access Communications System) trunked radio system. Already used by the City of Ottawa Police and all other City Departments (including EMS), EDACS serves as the backbone of the city's radio-communications network and provides coverage of the city's 1000-square-mile geographical area.

"The Ottawa Police and Public Works Department have used M/A-COM's EDACS system for years with complete satisfaction," said Don McCallan, division chief of communications for the Ottawa Fire Department. "As a result, it was a logical choice for us to deploy the same system for performance and interoperability with other departments. We are confident that M/A-COM's EDACS system will provide the same reliable, effective communications that the other departments have experienced."

"The EDACS system has the capabilities to support both current and future public-safety radio needs."

The EDACS system has the capabilities to support both current and future public-safety radio needs. In selecting a radio network, the Ottawa Fire Department desired a system that would not only enhance communications for public safety, but one that would also connect with all citywide departments.

The expanded M/A-COM trunked radio system will ensure mobile and portable communications for police officers and firefighters, as well as other city personnel who provide essential services to the public, such as street maintenance and utility services. The system will unite over 4000 users within the citywide departments and will support portable, on-the-street coverage for an area of the city's entire geographical area. As part of the agreement, M/A-COM will provide, assemble, and integrate all of the project's hardware and software as well as provide both user and administrative training.

"M/A-COM is looking forward to expanding the EDACS communications network for citizens and public-safety community of Ottawa," said Bill Hall, M/A-COM's account manager.

Attractive Cost Of 802.11b Drove Wi-Fi Shipments In 2002

SCOTTSDALE, AZ—The year 2002 proved to be stellar for wireless-local-area-network (WLAN) volume growth driven by increasingly cheap and reliable 802.11b technology, according to the high-tech market-research firm, In-Stat/MDR. The research firm reports that business Wi-Fi shipments are expected to rise 65 percent annually in 2002, to 11.6 million units and home shipments are expected to increase by a very healthy 160 percent, to 6.8 million units. However, fast and furiously falling prices for 802.11b equipment are expected to cause total market revenues to grow by only 23 percent, from $1.8 billion in 2001 to $2.2 billion in 2002.

"In 2002, security continued to be the most talked-about issue on the business side, while the Achilles heel of the home market remained multimedia support," said Gemma Paulo, a senior analyst with In-Stat/MDR. "In the year ahead, the continued growth and evolution of dual-mode 2.4/5-GHz capable equipment, Intel's ability to push out its Centrino mobile technology, the shift toward 802.11g as the preferred 2.4-GHz WLAN technology, and the Advent of new enterprise infrastructure technology, will all shape the development of this market."

"In 2002, security continued to be the most talked-about issue on the business side, while the Achilles heel of the home market remained multimedia support."

In-Stat/MDR's report, "It's Cheap and It Works: Wi-Fi Brings Wireless Networking to the Masses," includes five-year forecasts of the worldwide total WLAN equipment market, including Wi-Fi equipment, i.e., 802.11b, 802.11a, 802.11g, and dual-band 2.4/5-GHz products. Business and home/SOHO (small office, home office) Wi-Fi market forecasts are included, by technology and equipment type. In-Stat/MDR believes that the market's main measurable components include network-interface cards (NICs) and infrastructure equipment, which includes access points and bridges. This report gauges the size of the current market, and provides forecasts for the future, based on products shipped and end-use sales of these three product components.

Kudos

TEMPE, AZ—Motorola Labs has been named by *Scientific American* magazine as one of the "Scientific American 50"—the magazine's first list recognizing contributions during 2002 to science and technology providing a vision of a better future.

Motorola Labs was named Leader in the Chemicals and Materials category for its work on developing new semiconductor materials, particularly research related to layering compound semiconductor materials on silicon.

SAN DIEGO, CA—QUALCOMM, Inc. announced that two high school students—Chris Castello, a sophomore at Helix Charter High School, and Dorian Mattrey, a sophomore at La Jolla High School—are the winners of QUALCOMM's "Wireless Technology Touchdown" contest. The contest called for creative ideas on how wireless technology can enhance the sport of football and/or the spectator experience. Winners each received two tickets to Super Bowl XXXVII, which was held on January 26 at QUALCOMM Stadium in San Diego, as well as a $5000 academic scholarship toward their college education. QUALCOMM also donated $10,000 to the math and science departments at the winners' schools.

Castello's winning submission included a handheld device to assist in seat and facility location within the stadium, connecting to the snack bar, enabling people to order snacks from their seats and check football statistics or coaching strategies during the game.

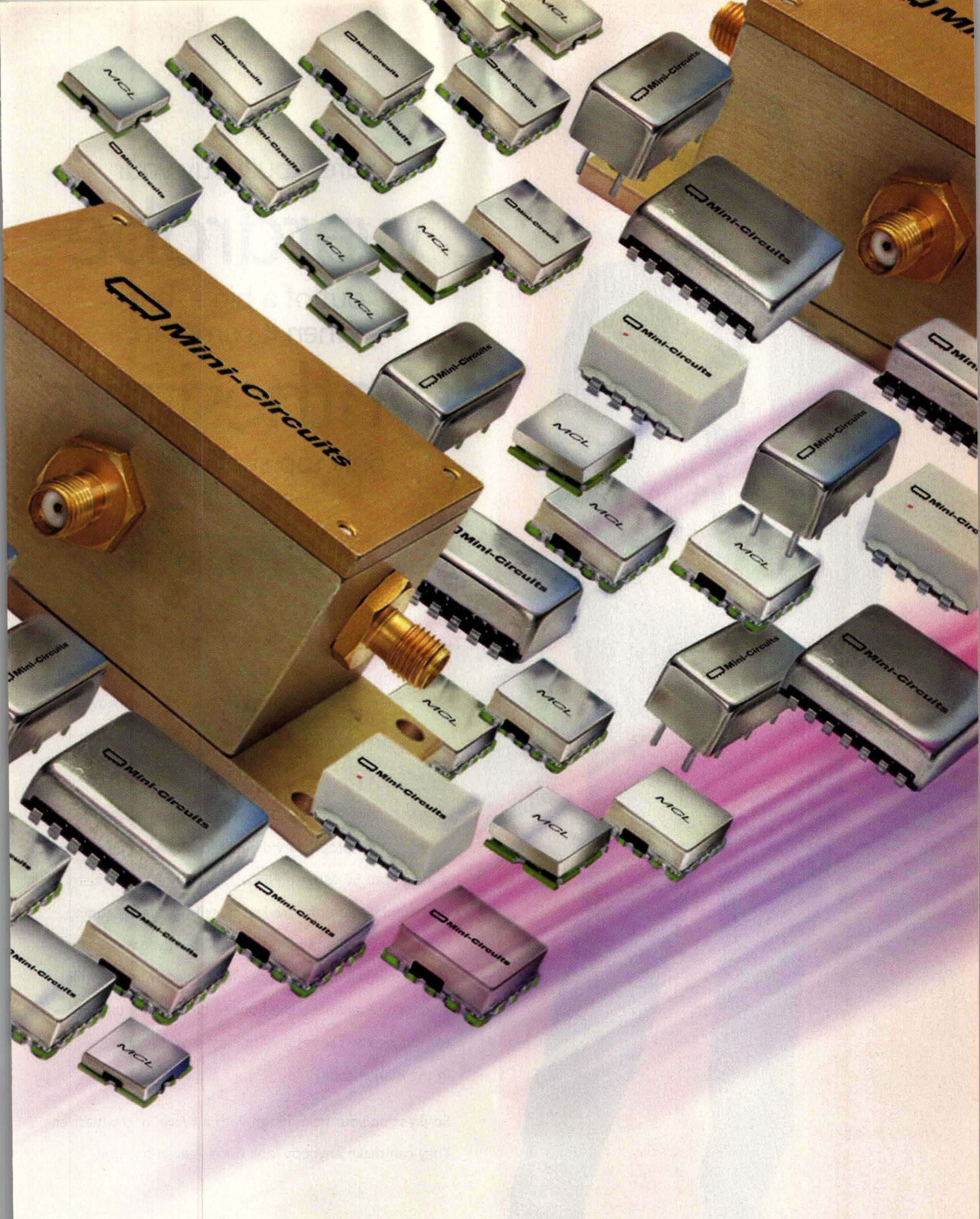
Mattrey recommended development of a new handheld technology combined with a helmet camera to allow stadium fans greater interaction with the game.

CHELMSFORD, MA—In 2002, Hittite continued to build their standard product portfolio with the release of 50 new RF IC/MMICs covering applications from DC to 42 GHz.

Notable additions for cellular/3G and broadband systems include: +36-dBm IIP3 mixers; +45-dBm OIP3 amplifiers; broadband gain blocks to 10 GHz; a low-phase-noise 2-GHz VCO; low-distortion +65-dBm IIP3 switches; 5.2-GHz WLAN diversity switches; and >55-dB isolation switches for LO multiplexing and CATV.

SANTA ANA, CA—Calmont Wire & Cable, Inc. was recently awarded a commemorative plaque from DuPont. The plaque reads: "In recognition of the innovative and dedication of Calmont Wire & Cable in manufacturing high-quality products with superior performance using DuPont's™ TEFZEL fluoropolymer resin."

DuPont recognizes Calmont's capability in the utilization of Tefzel® and Aracon® in a cable construction offering exceptional properties and benefits. MRF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NEWS

DSPs And Data Converters Enable Complex Modulation

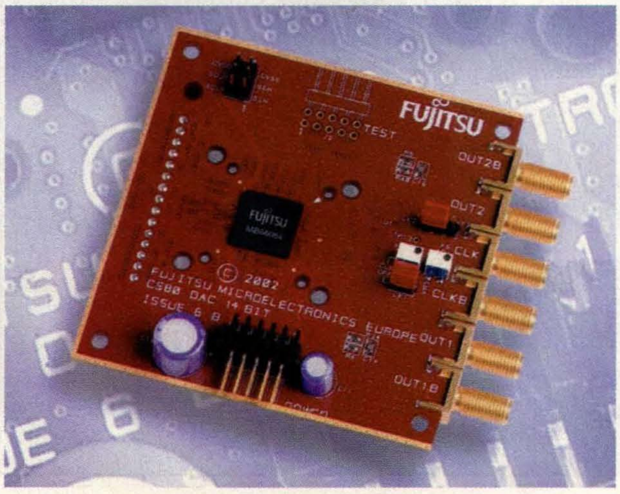
Some of the latest processors and converters provide the muscle to support the wide bandwidths and multiple-carrier capabilities of emerging cellular-infrastructure equipment.

JACK BROWNE
Publisher/Editor

Microwave and RF engineers have become more familiar with data converters and digital signal processors (DSPs) in recent years. These components are now mainstays in many wireless systems, making possible the complex filtering and algorithms employed in digital modulation schemes and multichannel communications architectures. In essence, analog-to-digital converters (ADCs) sample analog input signals, digital-to-analog converters (DACs) generate complex modulated waveforms for signal transmission, and DSPs provide the sophisticated filtering and signal manipulation in between the two converter types.

The general trend for ADCs, DACs, and DSPs is one of increased processing power at lower power-consumption levels. The recently introduced (see *Microwaves & RF*, February 2003, p. 118) TMS320VC5501 and TMS320VC5502 DSPs from Texas Instruments (Dallas, TX, www.ti.com) have dual multiply-and-accumulate (MAC) cores and 300-MHz clock speeds for prices starting at \$5. These LQPF-packaged devices consume only 200-mW power during normal operation.

The company also recently announced a series of new processors for Universal Mobile Telecommunications System (UMTS) applications, in accordance with the new Open Mobile Application Processor Interface (OMAPI)



Shown here on a test board, the model MB86064 dual 14-b DAC provides 800-MSamples/s sampling rate in support of carrier generation of GSM, WCDMA, and UMTS systems. (Photograph courtesy of Fujitsu Microelectronics, San Jose, CA.)

standard (which is comprised of a set of software interfaces to the operating system and a set of hardware intefaces defining common application peripheral devices). These OMAPI processors combine a DSP and a high-speed microcontroller on a single chip. Based on a 0.13-μm complementary-metal-oxide-semiconductor (CMOS) process, the OMAP1612 processor, for example, combines the company's TMS320C55x DSP core (capable of operation to 204 MHz) with an ARM926TEJ processor core (also capable of operation to 204 MHz). The OMAP1612 is available with 128 to 256 Mb of stacked mobile double-data-rate (DDR) synchronous-dynamic-random-access memory (SDRAM) to help reduce the size of cellular handsets and Personal Digital Assistants (PDAs) while also lending the processing power for wireless streaming-video and multimedia applications. The OMAP1612 offers a dedicated connection to the company's TNETW1130 wireless-local-area-network (WLAN) processor to simplify the interface with 54-Mb/s WLAN circuitry.

Texas Instruments recently established new standards in terms of processing speed with their 720-MHz models TMS320C6414, TMS320C6415, and TMS320C6416 DSPs. All three devices include 1 MB of on-chip memory with differences in peripheral support and inclusion of coprocessors (such as the integral Viterbi and Turbo coprocessors on the TMS320C6416). These high-speed DSPs are well suited for digital video, imaging, and wireless communications applications. (Note that more information on these three new devices is available by logging directly onto the company's website at www.ti.com/720mhzp.)

One of the earlier developers of DSP technology (as Lucent Technologies), Agere Systems (Allentown, PA, www.agere.com) entered the marketplace for dual-MAC DSPs with its model DSP16411. Operating at maximum clock rates to 285 MHz, the DSP is optimized for use with communications infrastructure equipment. In addition to its enhanced direct-memory-access (DMA) capabilities, the DSP features an on-chip programmable PLL clock synthesizer to eliminate the need for a high-speed clock input. It is designed for use with a single +3.3 VDC.

In addition to Motorola (Phoenix, AZ) as a supplier of DSPs, it should be noted that some suppliers of field-programmable gate arrays (FPGAs), including Altera Corp. (San Jose, CA) and Xilinx, Inc. (San Jose, CA), promote the use of their ICs for DSP functionality. For example, Altera's Stratix line

of FPGAs includes the embedded memory, embedded processors, and DSP blocks needed for high-speed DSP. The Stratix devices can provide 16 × 16 multiply operations at 270 MHz, for example.

At the recent Wireless Systems Design Conference & Expo (San Jose, CA), Fujitsu Microelectronics (San Jose, CA) announced their model MB86064 dual 14-b DAC for generation of carrier signals in Global System for Mobile Communications (GSM), wireless-code-division-multiple-access (WCDMA), and UMTS systems **(see figure)**. The 800-MSamples/s device supports the wide channel bandwidths of these emerging wireless systems. Fabricated with a 0.18-μm CMOS process, the presence of two DACs within a common package supports diversity-transmit or dual-transmit applications as well as high-speed test equipment.

Analog Devices (Wilmington, MA, www.analog.com) also made a strong showing at the Wireless Systems Design Conference & Expo with a number of new ICs. For example, the company recently launched a high-speed ADC as well as a DAC, both nominally for cellular applications. The ADC is the 14-b, 80-MSamples/s model AD9245 that consumes less than 500 mW power from a single +3-VDC supply. Available in a 32-pin chip-scale package (CSP), the ADC is ideal for microcells and picocells requiring low power consumption. The converter operates at 80 MSamples/s and supports input frequencies to 100 MHz. It uses a multistage differential pipelined architecture with output error-correction logic to provide 14-b accuracy over a wide temperature range. It features a signal-to-noise ratio of 72 dB and spurious-free dynamic range (SPDR) of –85 dBc. The converter includes a sample-and-hold (S/H) amplifier with a proprietary input sampling network that can be configured for single-ended or differential operation.

The general trend for ADCs, DACs, and DSPs is one of increased processing power at lower power-consumption levels.

The DAC is the model AD9786, a 16-b, 400 MSamples/s CMOS device that allows synthesis of signals at IFs of 140 MHz and higher. Ideal for multicarrier base stations, the DAC offers a noise floor of –163 dBm/Hz and 2×4×/8× selectable interpolation filters at a data rate of 160 MSamples/s. The DAC achieves IMD performance of better

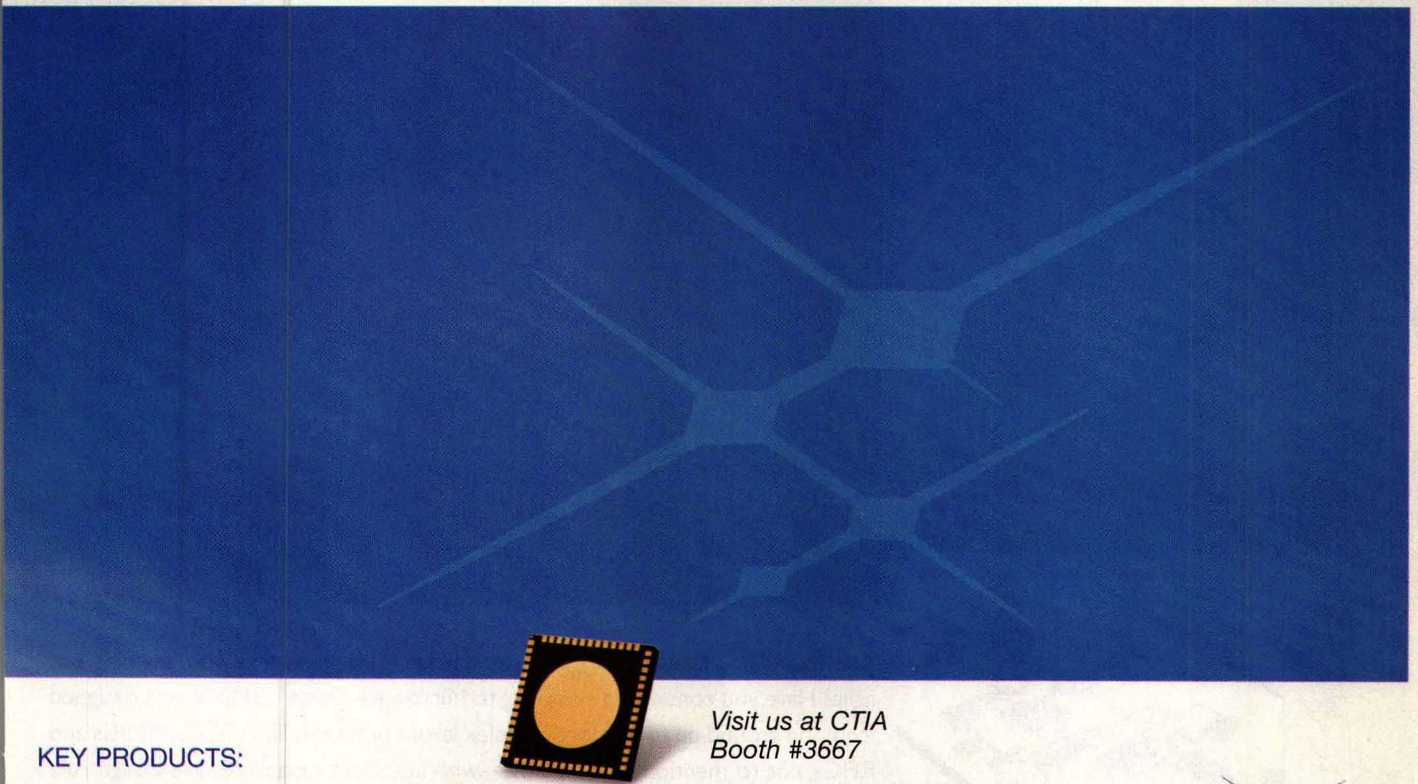
than –80 dBc to 300 MHz and SFDR of –90 dBc at 10 MHz.

For sampling applications at slightly less bit resolution, the firm's model AD12400 ADC offers 12-b resolution at 400 MSamples/s. suitable for both military radars and multichannel communications systems, the ADC achieves a SFDR of –75 dBc at 128 MHz and a SNR of 64 dB at the same carrier frequency. Supplied as a packaged module, the ADC features a transformer-coupled analog input and digital processing to achieve the wide dynamic range.

The company also unveiled several highly integrated solutions for wireless applications, including the models AD6635 and AD6652, multiple-channel radio receiver (Rx) processors. The AD6635, for example, is an eight-channel receive-signal processor (RSP) that is capable of processing as many as four cdma2000 or WCDMA channels or eight narrowband GSM or EDGE carriers simultaneously. It has four reconfigurable 80-MSamples/s RSP input channels and eight independent RSP shared-channel resources. The AD6652 is an integrated radio Rx with dual ADCs and RSPs. It is essentially a mixed-signal IF-to-baseband Rx that directly couples outputs from the dual 12-b ADCs to an on-board quad-channel multimode digital RSP. The company explains the RSP as a numeric preprocessor for a DSP, intended to replace the local oscillator (LO), quadrature mixer, channel-select filter, and data decimation found in a traditional superheterodyne radio architecture.

In terms of pure speed, the MAX108 ADC from Maxim Integrated Products (Sunnyvale, CA) manages 8-b resolution at 1.5 GSamples/s while supporting input bandwidths to 2.2 GHz. Designed for single-ended or differential use, the bipolar device is designed for ±5-VDC supplies and has an effective input signal range of ±250 mV. The company's MAX104 offers the same input bandwidth and 8-b resolution, but at a maximum sampling rate of 1 GSamples/s (see *Microwaves & RF*, March 1999, p. 128). Both ADCs benefit from a bipolar process capable of fabricating NPN transistors with transition frequencies in excess of 27 GHz.

Recently, the company introduced the MAX5888 DAC for multicarrier cellular base stations (see *Microwaves & RF*, November 2002, p. 95). Designed to generate as many as four UMTS carriers at bandwidths to 100 MHz, the 16-b DAC features a 500-Msamples/s update rate. The SFDR for the MAX5888 is typically –76 dBc when generating a 40-MHz output signal. The DAC dissipates less than 250 mW from a single +3.3-VDC supply. It provides a signal-to-noise ratio (SNR) of –155 dBc and two-tone IMD of –72 dBc for an 80-MHz output frequency. MRF



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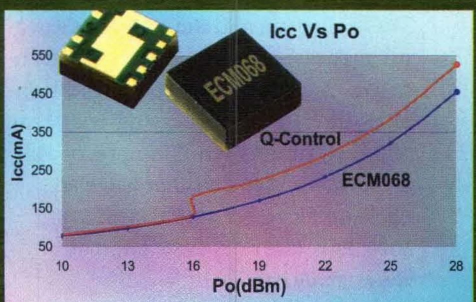

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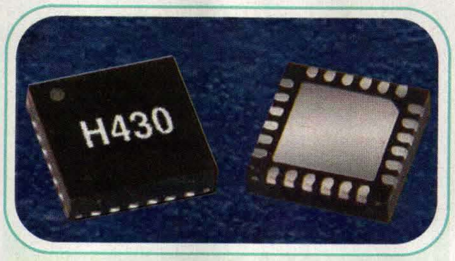
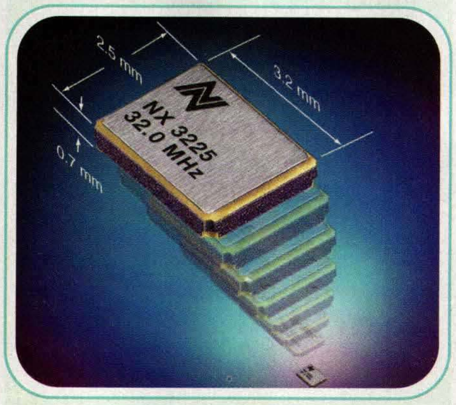
MMIC VCOs Tune C-Band To 6.1 GHz

A PAIR OF GaAs InGaP heterojunction-bipolar-transistor (HBT) monolithic-microwave-integrated-circuit (MMIC) voltage-controlled oscillators (VCOs) are designed for C-band applications from 5.0 to 6.1 GHz. Well suited for IEEE 802.11a or HiperLAN 5-GHz wireless local-area networks (WLANs), very-small-aperture-satellite (VSAT) terminals, and UNII-band and point-to-point radios, these VCOs consume only 27 mA from a single +3-VDC supply. Model HMC430LP4 provides a +2 dBm buffered output and low phase noise of –103 dBc/Hz phase noise offset 100 kHz from carriers of 5.0 to 5.5 GHz. Model HMC431LP4 provides a +2 dBm buffered output and low phase noise of –102 dBc/Hz phase noise offset 100 kHz from carriers of 5.5 to 6.1 GHz.

Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01842; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.



HITTITE MMIC VCO



NDK AMERICA MINIATURE CRYSTALS

Tiny Oscillator Tunes 5.7 To 7.7 GHz

VOLTAGE-CONTROLLED-OSCILLATOR (VCO) model OAS7700 operates from 5700 to 7700 MHz. It combines an oscillator circuit, lowpass filter, and MMIC amplifier in a standard surface-mount package. Designed for low phase noise and linear tuning, the OAS7700 features phase noise of better than –100 dBc/Hz offset 100 kHz from the carrier, with average tuning sensitivity of 150 MHz/V and 2:1 tuning linearity over frequency and temperature. The VCO, which is rated for operating temperatures from –54 to +85°C, provides +10 dBm output power with ±2 dB output-power flatness across the full frequency range. Harmonics are suppressed by at least –25 dBc. The VCO is designed for tuning voltages from 0 to 15 V, and draws 100 mA from a +5-VDC supply.

Cougar Components, 290 Santa Ana Court, Sunnyvale, CA 94085; (408) 522-3838, FAX: (408) 522-3839, Internet: www.cougarcorp.com

Miniature Crystals Resonate For Bluetooth

COMPACT DESIGNS REQUIRING miniature surface-mount crystals can now make use of the NX3225DA series which includes models operating at frequencies of 16, 20, 24, 26, and 32 MHz ad are available at frequencies from 16 to 55 MHz. The crystals measure only 3.2 × 2.5 × 0.6 mm and weigh just 17 mg. The frequency tolerance is ±10 PPM at +25°C. The crystals, which are rated for operating temperatures from –10 to +60°C, require only 10 µW drive and have a standard load capacitance of 10 pF. The lead-free crystals are ideal for Bluetooth and other wireless applications. P&A: $0.60 (10,000 qty); stock.

NDK America, Inc., 1701 E. Woodfield Rd., Suite 620, Schaumburg, IL 60173; (847) 517-2884, FAX: (847) 517-2887, e-mail: sales@ndkxtal.com, Internet: www.ndkxtal.com.

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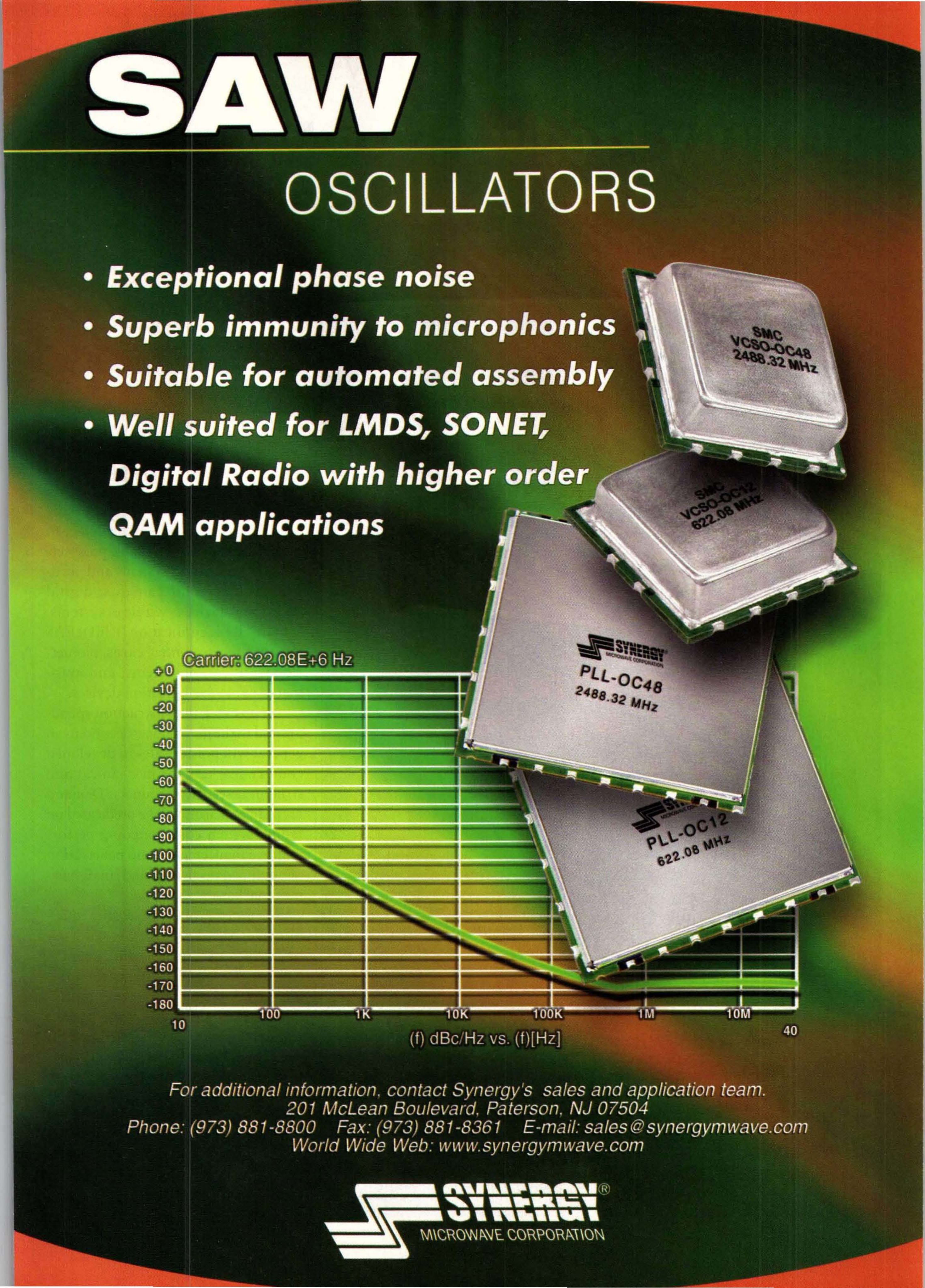
LECROY DSO

SiGe Front Ends Streamline Scopes

THE WAVEPRO 7300 and 7100 high-speed digital-storage oscilloscopes (DSOs) incorporate silicon-germanium-based front-end amplifiers and analog-to-digital converters (ADCs) to achieve jitter-free sampling of input signals at sampling rates to 20 GSamples/s. The WavePro 7300 offers a 3-GHz bandwidth while the 7100 has a 1-GHz bandwidth. The four-channel DSOs also provide single-shot sampling of 10 GSamples/s and a 2-ps-jitter noise floor. Signals are shown on a bright 10.4-in. (26.4-cm) SVGA display, and the company's proprietary fast-streaming X-Stream technology is used to overcome traditional trade-offs in processing the large amounts of data from long records.

LeCroy Corp., 700 Chestnut Ridge Rd., Chestnut Ridge, NY 10977; (845) 578-6020, FAX: (845) 578-5985, Internet: www.lecroy.com.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Carrier: 622.08E+6 Hz
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-10
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-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
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Security Products Are In Demand

THE WORLD MARKET FOR security products and systems is forecast to expand almost nine percent annually through 2006, reaching $65 billion. Heightened fears of terrorism in the wake of the September 11, 2001 attacks on the US, in tandem with rising conventional crime rates in many countries, will be the primary factor driving growth. Also important will be a robust pace of new product development, especially in the electronic security segment. These and other trends are presented in *World Security Products*, a study from The Freedonia Group, Inc., a Cleveland-based industrial market-research firm.

Higher-end electronic systems will log the best gains, based on less-penetrated markets, a high pace of new product development, falling prices, and the ability to thwart increasing threats ranging from retail shrinkage to terrorism. The most favorable prospects exist for higher-end systems and products such as color cameras, digital recording devices, wireless systems, "smart" RF identification (RFID) EAS tags and access-control cards, biometric identification systems, and automated explosive-detection devices.

An upswing in construction spending and in the global macroeconomy in general will bolster sales in developed country markets for mechanical and structural security products. Demand for burglar alarms will be predicated on falling system costs, ongoing performance enhancements, and penetration of untapped residential and small-business markets.

The fastest growth for security equipment is expected to be the world's developing regions—Asia, Latin America, Eastern Europe, Africa, and the Middle East. These areas feature largely unpenetrated private security markets and are characterized by rising crime rates, expanding economies, new business-formation activity heightened foreign investment, emerging middle and upper classes, and privitization of formerly state-owned industries such as banking and air travel. China will lead the pack, logging market growth in excess of 15 percent per annum through the end of the decade. MRF

CONTRACTS

Motorola's Global Telecom Solutions Sector (GTSS)—Has been awarded a $43 million contract by Tata Teleservices for deployment of a code-division-multiple-access (CDMA) 1X network in the Indian cities of Maharashtra, Mumbai, and Goa. The CDMA 1X network is designed to provide customers with data services at speeds of up to 144 kb/s in addition to regular voice services. The deployment is scheduled to be completed by May 2003.

EMS Technologies, Inc.—Has announced an expanded contract valued at $19.9 million to supply key defense-electronics hardware to Israel-based defense contractor Elisra Electronic Systems Ltd.

EMS' Space & Technology Group/Atlanta was awarded a $10.9 million contract with Elisra in 1998 to build phased-array-transmitter (PAT) units. The units are instrumental to locating and communicating with guided rockets. Last fall, EMS began delivering qualified units, which have been successful in field tests. Under the new contract, which runs through 2005, EMS will supply additional PATs to establish a maintenance facility for the hardware in Israel.

Radiotronix, Inc. and Kustom Signals—Entered into a supplier agreement for a wireless, high-fidelity audio link and base station for law-enforcement use. The value of the agreement is said to be over $1 million.

Poynting Antennas Ltd.—Has secured a multimillion-dollar Rand contract with Elson, an Athens-based company, to supply them with a complete range of broadband, high-power EW antennas. Elson is a subsidiary of SONAK S.A., which forms part of the AXON Holdings Group of companies.

The antennas will be used for transmitting high-power radio waves and monitoring the frequency spectrum over a wide band. The contract will run over a period of 20 months and includes the antenna designing and manufacturing that are specific to the clients' requirements.

FRESH STARTS

SoloMio Corp.—Announced that Telefónica Móviles España has selected the SoloMio Smart Call Services Platform as part of a framework agreement.

The agreement provides for other Telefónica Móviles operating companies to also use the Smart Call Platform. Telefónica Móviles España, the group's largest operator, is the first to have purchased the Smart Call Services Platform.

Andrew Corp. and Allen Telecom, Inc.—Signed a definitive agreement under which Andrew will acquire Allen in a stock-for-stock transaction valued at approximately $500 million.

di/dt, Inc.—Has been acquired by Power-One, Inc. di/dt is now a subsidiary of Power-One, and will continue its operations as "di/dt, a Power-One Company." Power-One is a designer and manufacturer of standard DC/DC converters, power supplies, and power-plant systems. Power-One was previously a stockholder and exclusive licensee of di/dt for key technology in the power industry.

Applied Wave Research, Inc.—Announced the relocation and expansion of the company's European headquarters in the United Kingdom. The new contact information for the UK office is: Applied Wave Research, Inc., 3rd Floor, Lyon Court, Walsworth Rd., Hitchin, Herts SG43 9SX, United Kingdom; 44 (0) 870 220 2334, FAX: 44 (0) 20 7504 3777. The new office will maintain responsibility for managing sales representatives and providing technical support throughout Europe.

QUALCOMM, Inc.—Announced that it will conduct the world's first GSM1x technology trial with China Unicom, the second-largest wireless-service provider in China. The trial will enable China Unicom's Global System for Mobile Communications (GSM) subscribers to access the high-speed data services of China Unicom's CDMA2000 1X wireless network and accelerate the commercial availability of GSM/CDMA dual-mode handsets.

China Unicom has an installed base of over eight million CDMA users and 60 million GSM users. The GSM1x trial will illustrate the technical feasibility of GSM1x technology as an option to allow China Unicom's existing GSM subscribers to take advantage of the benefits of enhanced CDMA2000 1X services, while preserving the existing GSM service layer and SIM-based subscription.

Anritsu Corp.—Purchased 500,000 shares of Nissho Electronics. With the purchase, worth an estimated $4.7 million, Anritsu holds a 2-percent ownership stake in Nissho Electronics. As part of the transaction, the two companies agree to partner in the development of IP communications and network solutions.

Anritsu and Nissho Electronics will leverage their relationship to develop IP measurement solutions for advanced IP applications, as well as Voice Over IP (VoIP) and network-security technology. The companies also plan to cross-sell IP products in Japan, co-develop IP network services, and co-expand the Chinese market.

Precision Plating Co.—Announced the formation of an Experimenting & Prototyping Lab (EPL) within its present production facility. The new EPL will allow Precision's customers to experiment with various plating finishes to discover the best appropriate materials and methods for the manufacturers' applications. Precision Plating will make the experimental products in-house for customers to performance-test the prototypes in real world applications.

Avnet Electronics Marketing's RF & Microwave Division—Has signed a North American distribution agreement with Skyworks Solutions, Inc. , a wireless semiconductor company that is focused on RF and complete cellular system solutions for mobile-communications applications. MRF


SAMYN

Samyn Named As GM For Littelfuse Electronics

Littelfuse, Inc. has appointed DAVID SAMYN as general manager of its electronics business. He was most recently vice president for global sales with Airfiber, Inc., an optical wireless telecom company in San Diego, CA.

LightPath Technologies, Inc.—TODD CHILDRESS to CFO; formerly vice president of finance. Also, EDWARD PATTON to vice president of marketing; formerly vice president of sales and marketing at Geltech, Inc.

Silicon Laboratories, Inc.—DAN ARTUSI to president and COO; formerly COO.

Etenna Corp.—SAM YOUNG to vice president of sales for the Western Americas and Asia-Pacific; formerly vice president of marketing for Hynix Semiconductor's Flash Business Unit. Also, JACK SHOYKHET to director of sales for the Eastern Americas and Europe; formerly vice president of sales operations and professional services with Telxon/Aironet Corp. In addition, ALEX VAUGHN to director of operations; formerly responsible for new product introduction and management of the customer-commitment process at Sanmina-SCI.

National Instruments—TIM DEHNE to senior vice president of R&D; formerly vice president of marketing and engineering. Also, ALEX DAVERN to CFO and senior vice president of manufacturing and IT operations; formerly CFO and vice president of IT. In addition, PETE ZOGAS to senior vice president of sales and marketing; formerly vice president of sales.

Optical Cable Corp.—CHARLES W. CARSON to senior vice president of marketing and strategy; formerly vice president of marketing and customer service for Pirelli Cables and Systems, North America.

Eagleware Corp.—MARK ZACHMANN to vice president of research and development; formerly founder and CEO of ZSoft Corp. Also, GARY KARSTEDT to vice president of sales; formerly operations manager at Agilent's Contact Center.

Broadband Services, Inc.—COREY WALKER to director of MapVantage GIS Operations; formerly vice president and general manager of engineering for AM Broadband Services, Inc.

SnapTrack, Inc.—DR. KAMIL A. GRAJSKI to senior vice president and general manager; formerly vice president of engineering.

Rockwell Collins—KENT L. STATLER to senior vice president of operations; formerly vice president of manufacturing operations.

Semflex—RON DESILETS to Western regional sales manager; formerly Mil/Aero business development specialist at Trompeter Electronics.

Calmont Wire & Cable, Inc.—LINDA CUNNINGHAM to sales engineer for the Southern California territory; formerly employed in the medical and computer industries.


CUNNINGHAM


WANG

Olympus Partnership Development Group (PDG)—PETER WANG to optical product marketing manager; formerly senior product manager for Alliance Fiber Optic Products.

Columbitech—ASA HOLMSTROM to the position of president; formerly CEO at Kvadrat Teknik AB. MRF

▸SHORT COURSES

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RF and Microwave Receiver Design
March 24-26 (Arlington, VA)
May 5-7 (Cincinnati, OH)
RF Power Amps, Classes A-S: How the Circuits Operate, How to Design Them, & When to Use Each
April 29-30 (Cape May, NJ)
May 8-9 (Cincinnati, OH)
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(315) 735-4217, FAX: (315) 735-4328
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St. Anne's College
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▸MEETINGS

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RF & Hyper Europe 2003
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Internet: www.birp.com/hyper

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CDMA-Based Data Transmitter Supports Embedded Sensing

MACHINE HEALTH MONITORING is a task well suited for an embedded wireless data transmitter. Unfortunately, because of the sometimes-harsh electrical environments posed by automated machine systems, a transmitter can face severe interference along the way of reporting on machine system health. For that reason, Robert Gao and Philipp Hunerberg of the Department of Mechanical and Industrial Engineering of the University of Massachusetts (Amherst, MA) explored the design of a wireless data transmitter based on code-division-multiple-access (CDMA) technology for embedded sensing applications. Backed by MATLAB computer simulations at 2.4 GHz, the researchers developed a prototype system aimed at monitoring the condition of machine bearings, but also suitable for data loggers and handheld measuring equipment. The system consisted on an RF interface, DSP chip, sensor input port, and memory interface. See "Design of A CDMA-Based Wireless Data Transmitter for Embedded Sensing," *IEEE Transactions on Instrumentation and Measurement,* December 2002, Vol. 51, No. 6, p. 1259.

Printed-Array Antenna Offers Almost 120-Percent Bandwidth

AN ULTRABROADBAND ANTENNA was designed nominally to bridge several communications standards, such as 3G cellular, Bluetooth, and WLANs, with a single device. A design developed by Kamran Ghorbani of RMI University (Melbourne, Australia) and Rod B. Waterhouse of Dorsal Networks (Columbia, MD) consists of a diplexer and two aperture stacked patch antennas. It achieves gain from 0.7 to almost 4 GHz with 10-dB bandwidth of almost 120 percent. See "Ultrabroadband Printed (UBP) Antenna," *IEEE Transactions on Antennas and Propagation,* December 2002, Vol. 50, No. 12, p. 1697.

Broadband Analog Phase Shifter Controls 360-deg. Range At L-Band

ANALOG PHASE SHIFTERS AT L-BAND do not commonly provide a phase-control range as broad as 360 deg. But that is what several researchers from Hong Kong recently achieved for a device capable of operating from 1 to 2 GHz. K. Liu, E.Y B. Pun, and X.J. Tian of the Department of Electrical Engineering of the City University of Hong Kong (Kowloon, Hong Kong) described a monolithic design based on varactor diodes with a total phase shift of 360 deg. from 1.2 to 2.0 GHz. With less than 2-dB insertion loss across the operating band, the phase shifter also achieved linear deviation of less ±2.5 percent.

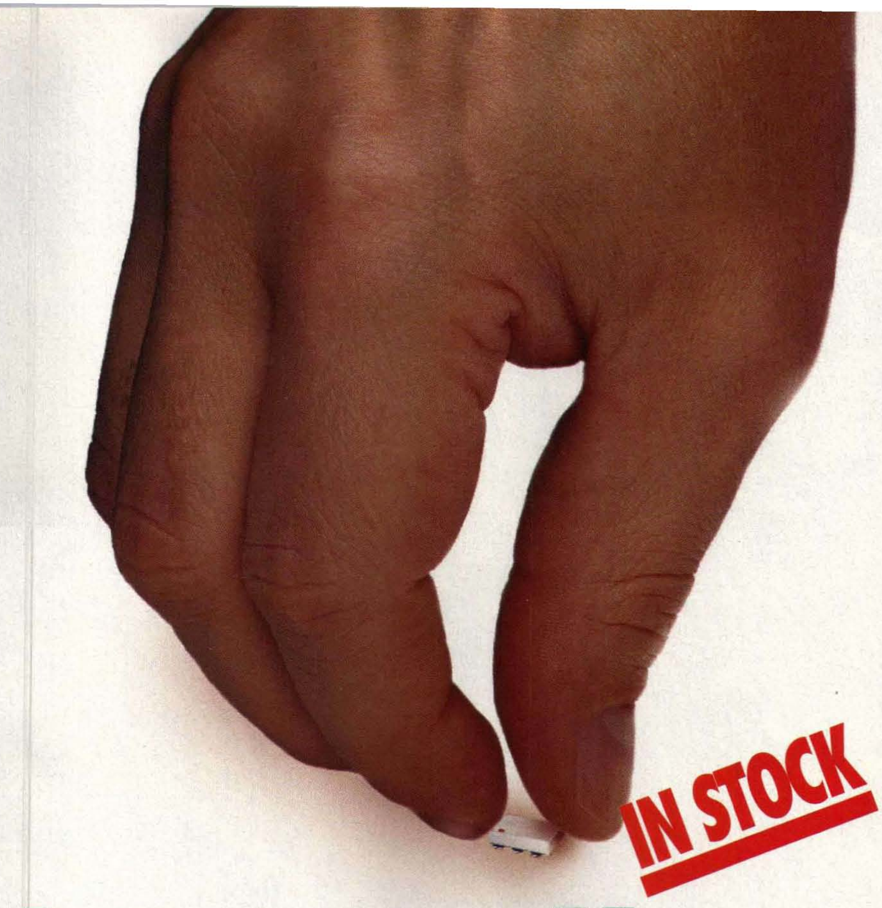
The reflection-type phase shifter consists of two varactor diodes connected in parallel with quarter-wavelength transmission lines joining the diodes. The phase shift is produced by varying the capacitance of the varactor diodes according to the applied bias voltage. In essence, careful selection of the varactor diodes, along with computer-aided-engineering (CAE) circuit optimization, was critical to achieving the three sometimes conflicting goals of 360-deg. phase shift, broad bandwidth, and linear phase shift. Using a three-port circulator to connect the phase shifter to test equipment, measurements on the component revealed performance values that were very close to computer-simulated values. By studying this design, the researchers developed new bandwidth design equations to support improved phase-shifter designs.

See "L-Band 360° Broad-bandwidth Monolithic Analog Phase Shifter," *Microwave and Optical Technology Letters,* February 5, 2003, Vol. 36, No. 3, p. 164.

Studying DTV Antenna And Receiver Mismatch Effects

ANTENNA AND RECEIVER MISMATCH effects have been studied extensively in military systems, but similar research has also been conducted recently in digital-television (DTV) broadcast systems. Work performed by Denise Schnelle and R. Evans Wetmore of the News Technology Group of Fox Entertainment Group (Los Angeles, CA) investigated the effects of different receiving antennas on DTV reception.

Laboratory measurements revealed that DTV receivers can operate with signal levels as low as –80 dBm, although the effects of mismatch can render a receiver ineffective even wit higher signal levels. The researchers tested 12 commercial antennas and discovered that those with the lowest return losses and mismatch losses delivered the best DTV performance, although not all of the antennas provided adequate performance levels under all conditions. See "Evaluation of Antenna and Receiver Mismatch Effects on DTV Reception," Cross-Correlation Noise Measurement in A/D Converters," *IEEE Transactions on Broadcasting,* December 2002, Vol. 48, No. 4, p. 365.



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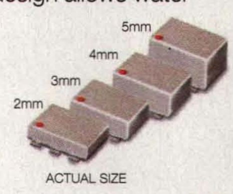

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ADE-3L	+3	0.2-400	5.3	47	10	4	4.25
ADEX-10L	+4	10-1000	7.2	60	16	3	2.95
ADE-1	+7	0.5-500	5.0	55	15	4	1.99▲
ADE-1ASK	+7	2-600	5.3	50	16	3	3.95
ADE-2	+7	5-1000	6.67	47	20	3	1.99▲
ADE-2ASK	+7	1-1000	5.4	45	12	3	4.25
ADE-6	+7	0.05-250	4.6	40	10	5	4.95
ADEX-10	+7	10-1000	6.8	60	16	3	2.95
ADE-12	+7	50-1000	7.0	35	17	2	2.95
ADE-4	+7	200-1000	6.8	53	15	3	4.25
ADE-14	+7	800-1000	7.4	32	17	2	3.25
ADE-901	+7	800-1000	5.9	32	13	3	2.95
ADE-5	+7	5-1500	6.6	40	15	3	3.45
ADE-5X	+7	5-1500	6.2	33	8	3	2.95
ADE-13	+7	50-1600	8.1	40	11	2	3.10
ADE-11X	+7	10-2000	7.1	36	9	3	1.99▲
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ADE-3G	+7	2300-2700	5.6	36	13	3	3.45
ADE-28	+7	1500-2800	5.1	30	8	3	5.95
ADE-30	+7	200-3000	4.5	35	14	3	6.95
ADE-32	+7	2500-3200	5.4	29	15	3	6.95
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ADE-12MH	+13	10-1200	6.3	45	22	3	6.45
ADE-25MH	+13	5-2500	6.9	34	18	3	6.95
ADE-35MH	+13	5-3500	6.9	33	18	3	9.95
ADE-42MH	+13	5-4200	7.5	29	17	3	14.95
ADE-1H	+17	0.5-500	5.3	52	23	4	4.95
ADE-1HW	+17	5-750	6.0	48	26	3	6.45
ADEX-10H	+17	10-1000	7.0	55	22	3	3.45
ADE-10H	+17	400-1000	7.0	39	30	3	7.95
ADE-12H	+17	500-1200	6.7	34	28	3	8.95
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ADE-20H	+17	1500-2000	5.2	29	24	3	8.95

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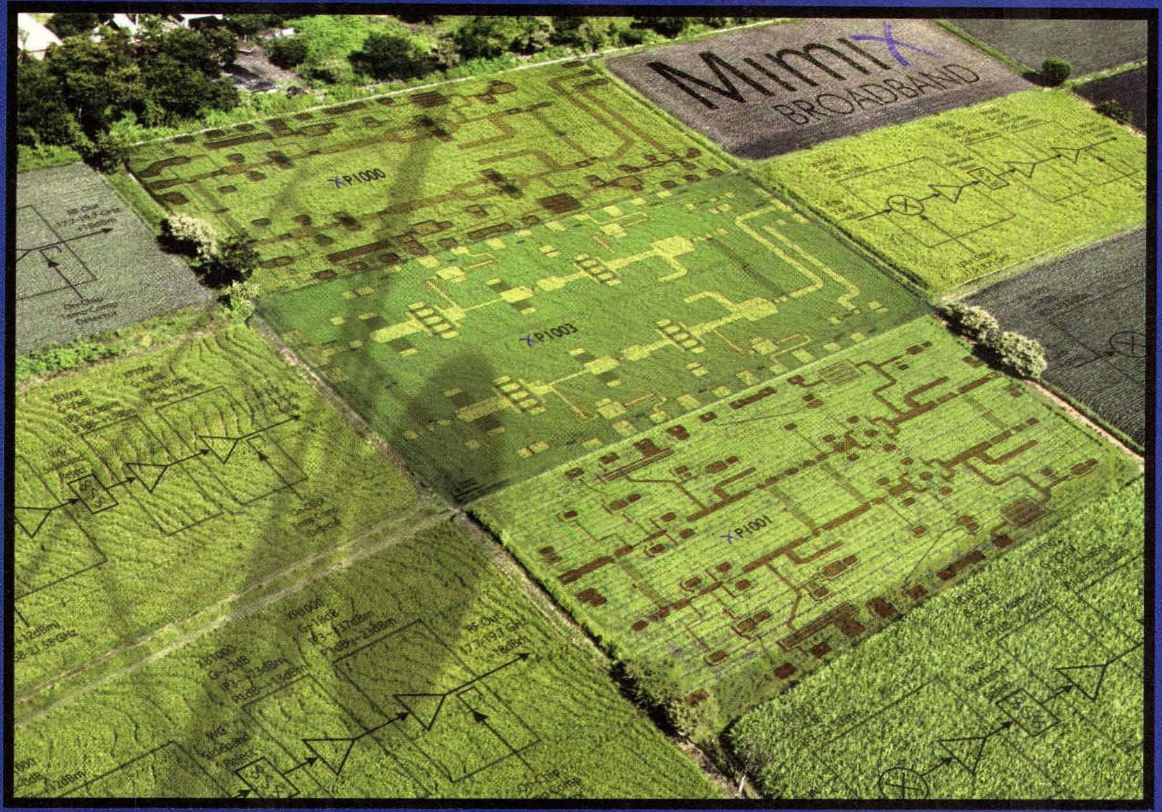

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DESIGN

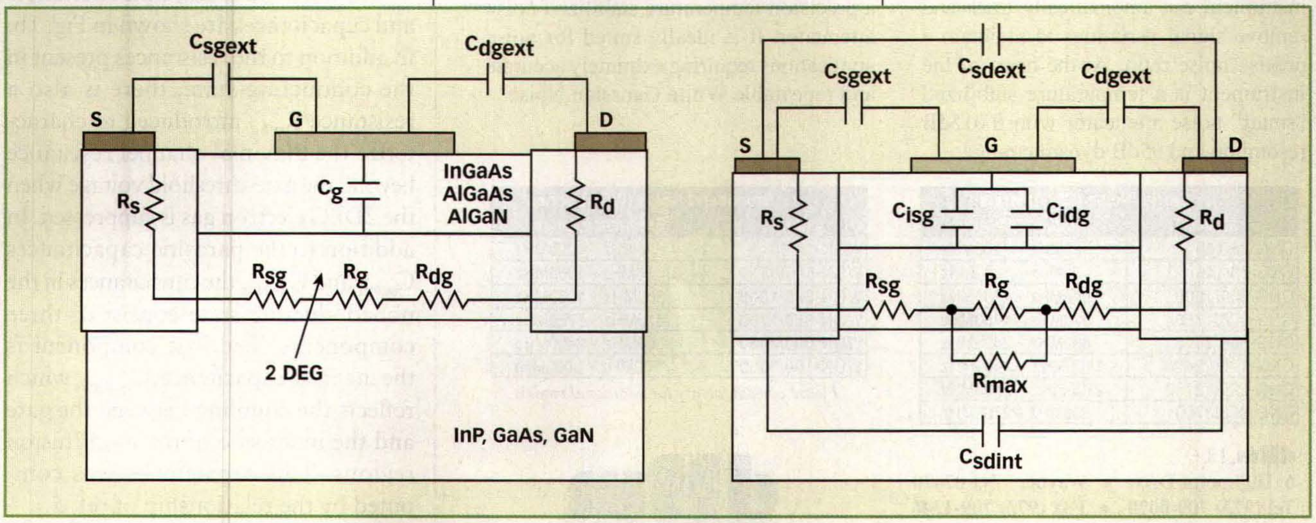
Comparing High-Frequency Control Devices

Three different semiconductor processes, based on the use of GaAs, InP, and GaN HEMT devices, were compared for their suitability as microwave switches.

MOHAMED KAMECHE AND MOHAMMED BEKHTI
Members of the Technical Staff
National Centre of Space Techniques, Algeria, BP 13, 1 Avenue de la Palestine, 31200 – Arzew – Algeria; (00) 213 41 47 22 17 FAX: (00) 213 41 47 34 54.

Solid-state switches can be fabricated with a variety of different semiconductor technologies, usually selected on the basis of performance requirements. For this study, single-pole, single-throw (SPST) switches were evaluated based on three different high-electron-mobility-transistor (HEMT) devices: InP, GaAs, and GaN. Although the least-mature process, the GaN HEMT switches exhibited high breakdown voltages compared to the other two processes, with better power handling (to +15 dBm without degradation in RF isolation and insertion loss).

Such solid-state switches have been used successfully as control devices for transmitter (Tx) and receiver (Rx) switching functions in a variety of digital communications systems. The choice of semiconductor material for these devices is generally dictated by the material's critical breakdown field, its saturation drift velocity, and its thermal conductivity. GaAs- and InP-based HEMT switches offer high isolation, low insertion loss, and high switching speed[1] but are limited in power-handling capabilities due to modest critical breakdown fields. On the other hand, due to



1. These diagrams show the origins of the resistances and capacitances for two states of a HEMT control device: (a) in the conducting or "on" state and (b) in the nonconducting or "off" state.

its wide bandgap structure, AlGaN/GaN HEMTs are ideal for realizing microwave control and amplification functions.[2]

GaN is a wide bandgap semiconductor material, with a high critical breakdown field, high saturation drift velocity, and good thermal conductivity compared to GaAs and InP (**Table 1**). If offers more than twice the bandgap energy of InP and GaAs materials,

Table 1: Comparing GaAs, InP, and GaN properties at 300 K.

	GaAs	InP	GaN
BANDGAP ENERGY (eV)	1.43	1.34	3.4
SATURATION VELOCITY (m/s)	10_5	$0.9 \times 10_5$	$2.7 \times 10_5$
CRITICAL BREAKDOWN FIELD (MV/m)	40	50	330
RELATIVE DIELECTRIC CONSTANT	12.8	12.5	8.9
THERMAL CONDUCTIVITY (W/mK)	50	69	170

with more than three times the thermal conductivity of GaAs (implying better power-handling capability).

To evaluate the three semiconductor materials, a HEMT device structure was selected as optimum for high-frequency switching and control functions. The resistances and capacitances forming the HEMT equivalent circuit can be subdivided into configurations representing the two switch states (on and off). For most control applications, at frequencies of most interest, the on-state impedance is mostly resistive while the off-state impedance is mostly capacitive. **Figure 1(a)** shows the physical origin of the various important resistances and capacitances in the conducting state. The resistances present in this state are the channel resistance, R_{ch}, and the parasitic source resistance, R_s and parasitic drain resistance, R_d. The capacitances present in the on-state configuration are the gate capacitance, C_g, the extrinsic drain-gate capacitance, C_{dgext}, and the extrinsic source-gate capacitance, C_{sgext}. These resistances and capacitances are estimated using the same techniques used in refs. 3 and 4.

The nonconducting-state resistances and capacitances are shown in Fig. 1b. In addition to the resistances present in the conducting-state, there is also a resistance R_{max} introduced to characterize the maximal channel resistance beyond the gate-threshold voltage when the 2DEG electron gas is suppressed. In addition to the parasitic capacitances C_{sgext} and C_{dgext}, the capacitances in the nonconducting state consist of three components. The first component is the intrinsic capacitance, $C_{igs(gd)}$ which reflects the coupling between the gate and the inner side of the n+ diffusion regions. This capacitance was computed by the relationship of ref. 5.

The second component is the intrin-

sic capacitance C_{sdint} that couples through the GaAs substrate. The third component is the extrinsic capacitance C_{sdext} that couples through the air, namely the metallic source-to-drain coupling capacitance. Determining the values of these last two elements is based on the relationships of ref. 3. The model used in this article includes an additional capacitance corresponding to the InGaAs, AlGaAs, or AlGaN neutralization.

Finally, the modeled capacitances and resistances can be combined to form an equivalent circuit that represents the two states of the HEMT control device. It is well known that the on-state resistance, R_{ON}, and the off-state capacitance, C_{OFF}, are the key equivalent-circuit elements used in characterizing broadband HEMT switches. The broadband cutoff frequency figure of merit, f_c, can be defined as:

$$f_c = \frac{1}{(2\pi R_{ON}\ C_{OFF})} \qquad (1)$$

Because R_{SD} and C_{SD} are key equivalent-circuit parameters affecting HEMT device and switch performance over gate voltage and input power, this analysis will focus on these two parameters.

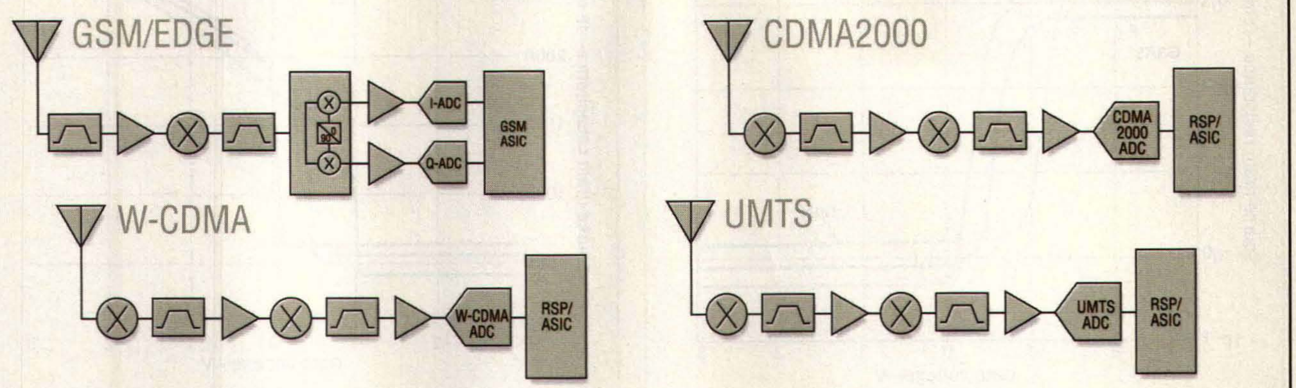
Figures 2 and 3 show computed characteristics of the normalized source-drain resistance and capacitance at a frequency of 1 GHz for three different technologies. A significant dependence of the extracted total source-drain resistance on V_g can be observed. When the gate voltage decreases toward the threshold voltage (–0.1 V for InGaAs/InP, –0.46 V for AlGaAs/GaAs, and –1.04 V for AlGaN/GaN), R_{SD} increases rapidly. This is in good agreement with the results obtained by Caverly[5] on modeling the AlGaN/GaN HEMT. In the gate-voltage range greater than the threshold voltage, R_{SD} is rather flat, which is a good evaluation of the on-state resistance, R_{ON}. Due to the lower bandgap energy, the InGaAs/InP HEMT offers a lower on-state resistance compared to the other two devices, which leads to improved high-speed switching.

Figure 7 shows simulated source-

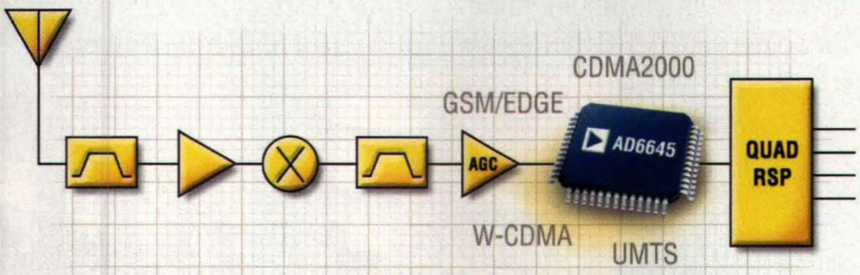
Table 2: Comparing cutoff frequencies and breakdown voltages for the switch technologies.

TECHNOLOGY	BROADBAND CUTOFF FREQUENCY (GHz)	BREAKDOWN VOLTAGE (V)
InGaAs/InP HEMT	565	5.5
AlGaAs/GaAs HEMT	400	9.5
AlGaN/GaN HEMT	285	80

Multiple air standards, multiple converters.



Multiple air standards, one converter.



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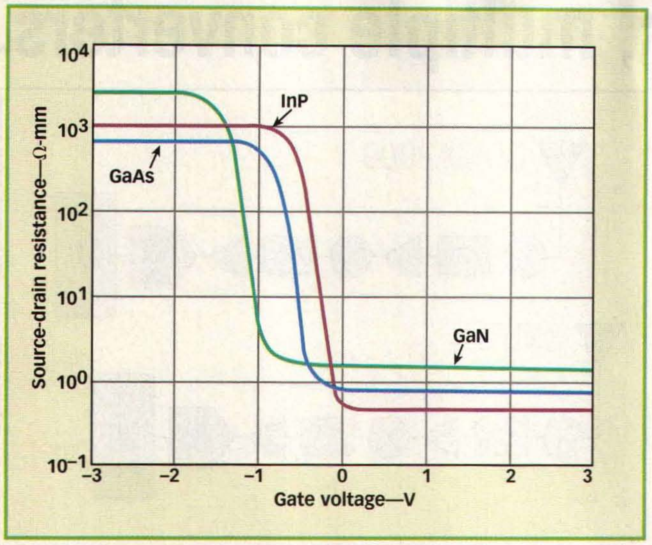
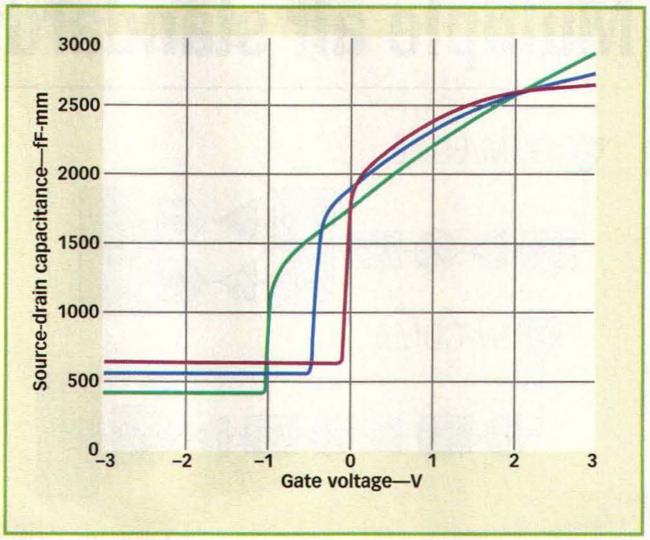


2. Source-drain switch resistance versus gate-voltage curves are shown for InP, GaAs, and GaN HEMT switches at 1 GHz.



3. Source-drain switch capacitance versus gate-voltage curves are compared for InP, GaAs, and GaN HEMT switches at 1 GHz.

drain capacitance for three devices. Under off-state biasing conditions, the variation of C_{SD} is dominated by the extrinsic capacitances, which depend upon the FET layout. The GaN-based HEMT presents the lower C_{OFF}, because of its low relative dielectric constant. When the on-state HEMT was biased, the total capacitance presented approximately the same variations.

Insertion loss and isolation are shown in **Figs. 4 and 5** as a function of gate voltage for various technologies, for devices with a gate periphery of 200 μm. For the shunt connected switch, the InGaAs/InP HEMT switch presents a small variation on the level of insertion loss compared to the other tech-

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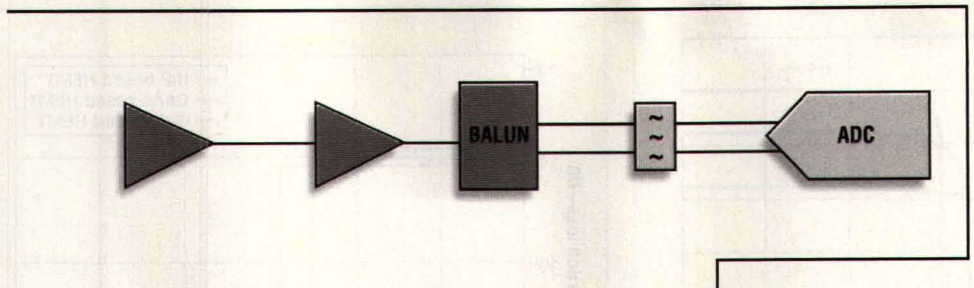

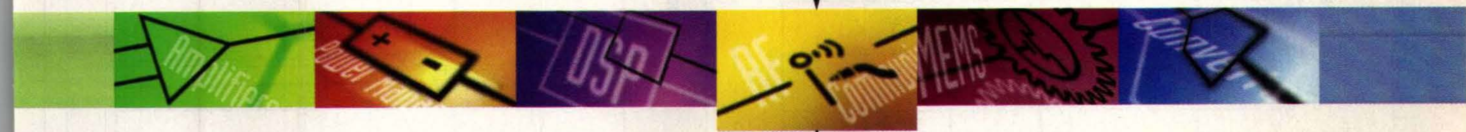

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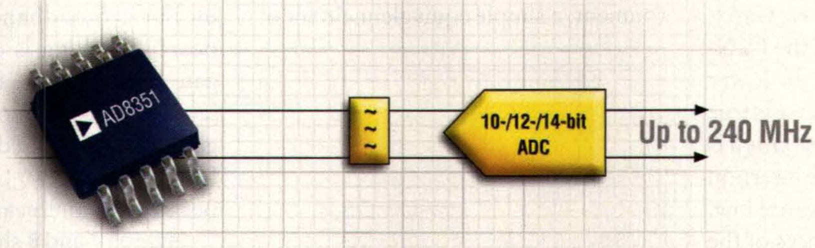

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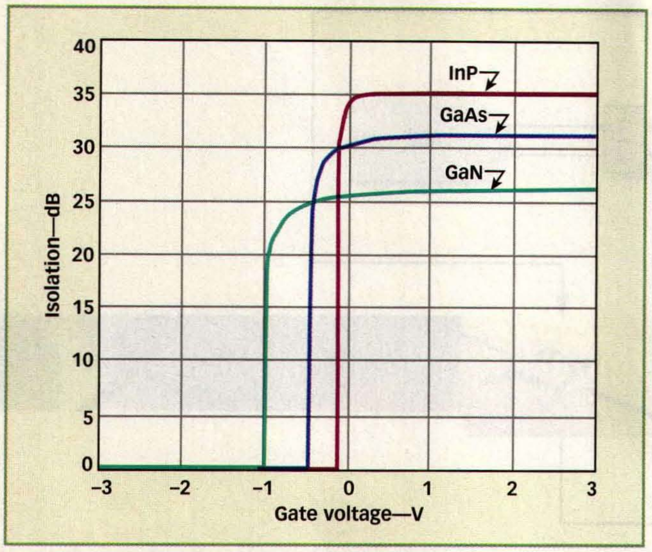
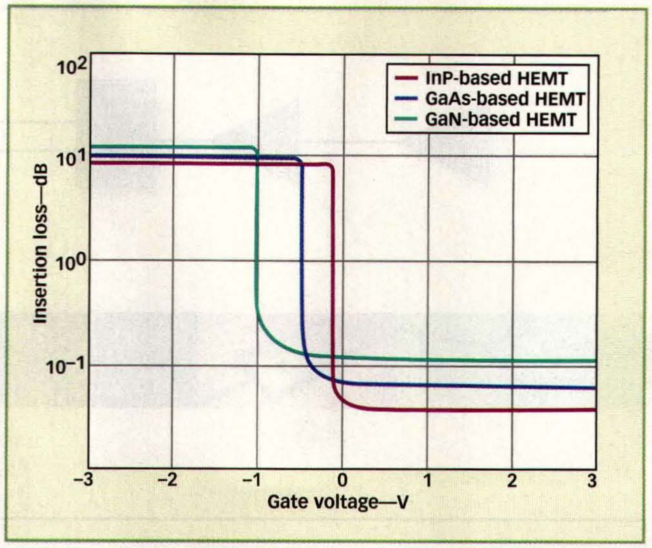


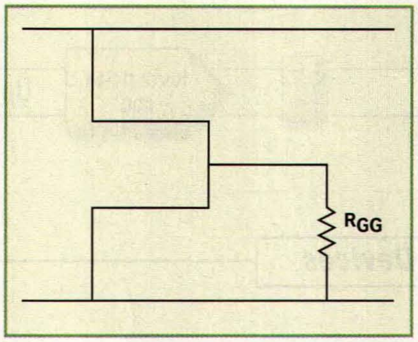
4. Shunt connected switch loss versus gate-voltage curves are shown for InP, GaAs, and GaN HEMT switches at 1 GHz.



5. Series connected switch loss versus gate-voltage curves are compared for InP, GaAs, and GaN HEMT switches at 1 GHz.

nologies, but demonstrated an improvement of isolation of 4 dB than GaAs-based HEMT and 9 dB than the GaN-based HEMT switches due to lower on-state resistance. The converse is true in the series case, where the isolation is approximately constant. The insertion losses of the three technologies are low, due the low on-state resistances of the InGaAs/InP, AlGaAs/GaAs, and AlGaN/GaN HEMT switches.

The power-handling characteristics of each technology in microwave control applications were also investigated. To define the total resistance and the total capacitance in large-signal environment, a simple equivalent circuit of



6. This simple diagram shows a shunt HEMT switch configuration.

the shunt HEMT switch was used **(Fig. 6)**. For a broadband HEMT switch, power handling is dependent on the gate-bias circuitry. For improved isolation of the gate-control voltage, the gate is usually biased with a large gate-bias resistance, R_{GG}, or a resistor incorporated monolithically within the gate.

Figures 7 and 8 show the variations of R_{SD} and C_{SD}, respectively, with input power for the three types of HEMT switches at 1 GHz. When the on-state HEMT was biased, the on-state resistance increases with increasing input

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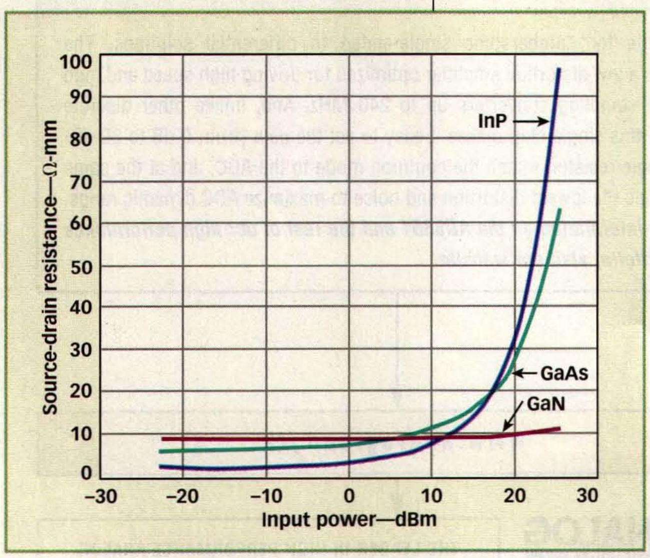
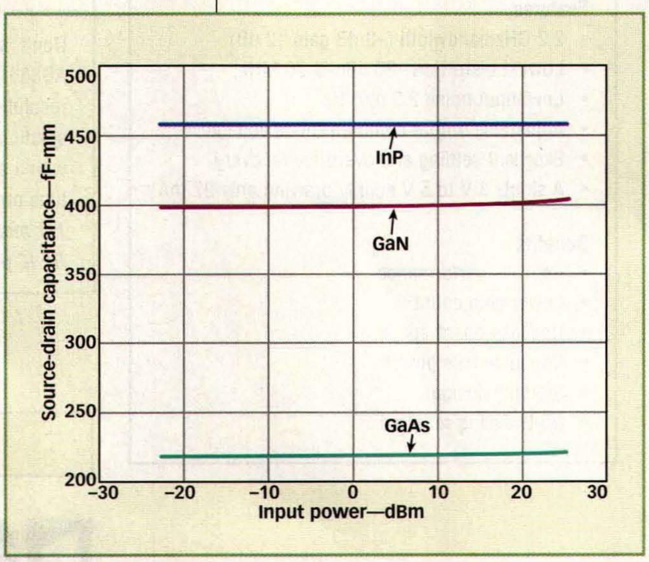


7. On-state resistance versus input power curves are shown for the three switches at a gate voltage of 1 VDC at 1 GHz.



8. On-state capacitance versus input power curves are shown for the three switches at a gate voltage of 1 VDC at 1 GHz.

Wireless Approach Monitors Tire Pressure

Several methods are available for remote monitoring the air pressure of vehicle tires, but highly integrated wireless circuits may offer the most reliable and accurate solutions.

Tire-pressure monitoring (TPM) is among the more useful, albeit humble, of wireless applications. Although application-specific integrated circuits (ASICs) have been commonly used for TPM functions, several integrated solutions from Atmel (San Jose, CA) can simplify the addition of wireless TPM functions to automotive telematics systems. These ICs are available with adequate on-board memory to support tire identification for production, service, and control purposes. This level of integration even helps keep vehicle tires in balance.

MARTIN MOTZ
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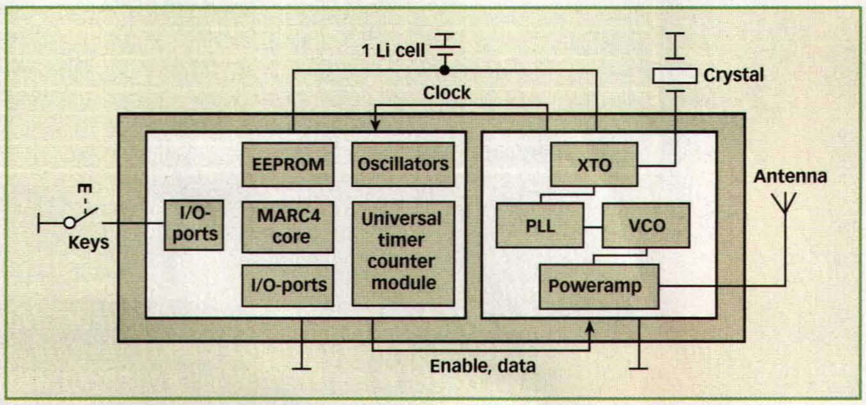
Most tire air-pressure losses occur from slow leaks in which the pressure may escape over hours, days, or even months; only a few percent of air-pressure losses are due to immediate incidents because of contact with road hazards. Slow leaks may be caused by different factors such as natural leakage, permeation, or seasonal climatic changes. Furthermore, slight damage to a tire by a road hazard that punctures small holes in the tire have been detected as a typical reason of slow air-pressure losses. When a tire is used while significantly under-inflated, its sidewalls flex more and the air temperature inside increases, making the tire more prone to failure. In addition, significantly under-inflated tires lose lateral traction, making handling more difficult. High-quality tires with optimum air pressure are equivalent to a life-



1. This block diagram of the T48C862/ATAR862 module shows the ATAM893 and T575x ICs requiring only a low-cost crystal, external antenna, and power supply (battery) for a complete TMP system.

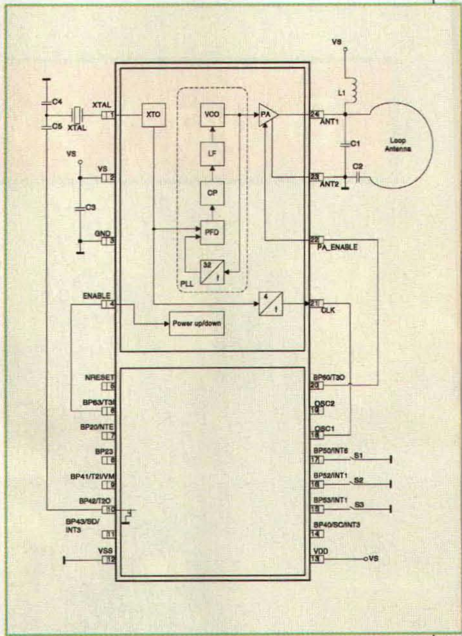
insurance policy for drivers, passengers, and the vehicles themselves. Tire-related problems account for many vehicle breakdowns. Most drivers do not regularly monitor their tires, inviting dangerous conditions.

To identify slow pressure leaks and to guarantee that the driver will be warned, two automotive TPM methodologies have evolved during the past 15 years: indirect sensing systems and direct sensing systems. In the first type, the tire pressure is evaluated based on the rotational speed of a vehicle's wheel relative to the other wheels. These systems—usually linked to an automatic braking system (ABS)—compare the rotation of the wheels to determine if a wheel is under-inflated. In direct sensor systems, encapsulated tire module boards contain pressure and temperature sensors to perform an on-going series of measurements on the tire pressure and temperature. These modules are mounted in the wheel and transmit an RF signal containing the tire-pressure and temperature information to a central receiver (Rx) in the vehicle.

Early TPM systems were introduced with the indirect sensing method. The differential speed detection of the indirect pressure sensing system has several inherit weaknesses, including the fact that the loss of tire pressure cannot be detected for all four tires at a similar rate. Even monitoring two tires on the same side or axis can result in ambiguous results. In addition, the correlation of tire temperature to air pressure is not included in the indirect method, and drop in tire pressure of less than 15 percent cannot be detected with the indirect method. A system calibration time of several minutes and up to hours would be needed to teach the variables associated with distinct tire types at differential driving preconditions. The detection of under-inflated tires itself requires several minutes. The detection and determination of which tire is under-inflated is an unsolved problem. An incorrect indication of under-inflated tires has been found in certain circumstances.

Direct-sensor TPM systems have been developed to overcome the limi-

tations of indirect sensing systems. Dedicated tire-pressure monitoring is now possible, even when all four wheels are involved. The tire-pressure monitoring can also operate when the vehicle is stationary. Smooth pressure decrease can be monitored easily. Advances in direct-sensor circuitry has enabled these modules to run under battery power with low current consumption, and new technologies that use RF energy supplied from the car body module, thus avoiding a battery supply, are in development.



2. This package diagram of the T48C862/ATAR862 module shows the pin assignments for the two ICs, including connections for an external loop antenna.

Currently, microcontrollers are becoming more relevant to improving the tire-pressure monitoring solution in tire modules. Flexibility of the system definition is becoming an important requirement for production and service resulting in the integration of the electronically erasable programmable-read-only memory (EEPROM). The EEPROM can also be used for the programming of the tire-identification (ID) code during tire installation.

Due to battery-life requirements, the power consumption of the tire-pressure module is a key performance requirement. Currently, standby or sleep modes along with duty cycling of the RF transmission are used to obtain the lowest power consumption. However, no matter how successful these different techniques are, market focus will continue to be on the development of a TPM IC with even lower current consumption. Furthermore, TPM module systems must be optimized for minimum weight, size, and cost. These improvements will lead to a higher acceptance of the direct TPM approach, allowing the introduction of direct TPM into new vehi-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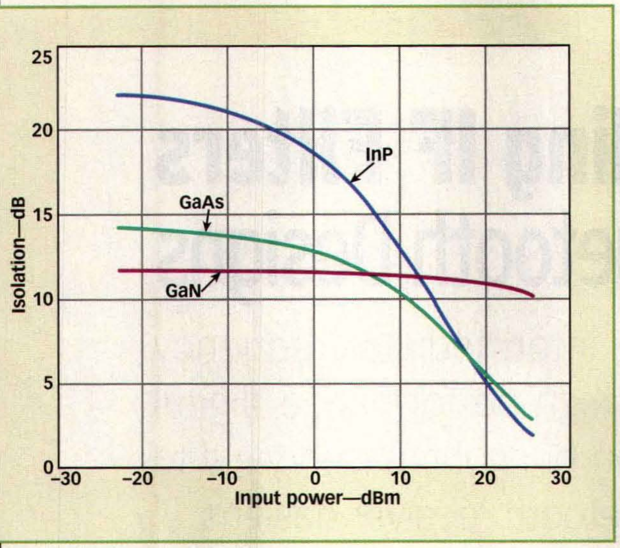
cle models with a high adoption rate.

All of the silicon (Si)-based ICs and components needed to construct TPM ultra-high-frequency (UHF) communications channels are available from Atmel. The firm currently supplies components to several commercial TPM module platforms. For example, the company's model AT86RF401 is an AVR-based 8-b microcontroller with integrated UHF phase-locked-loop (PLL) transmitter (Tx) designed for amplitude-shift-keying (ASK) modulation supplied as a single complementary-metal-oxide-semiconductor (CMOS) device. Ideal for direct-sensing TPM applications, the device is housed in a TSSOP20 package. It is capable of maximum transmit power of +6 dBm, and offers a 36-dB RF output-power control range, adjustable in 1-dB steps. The device is specified for reliable operation over typical automotive temperature ranges. It is available as a flash version and requires only a crystal resonator, three capacitors, an inductor, and a tuned loop antenna to implement a complete on-off-keyed (OOK) UHF Tx operating in the 264-to-456-MHz frequency range. The IC is typically powered by a single lithium (Li)-type coin-cell battery and designed to operate with minimum voltage of +2 VDC.

The company also offers the model ATAR862 integrated TPM module **(Fig. 1)** as a customized mask read-only-memory (ROM) version supplied in a SS024 package. The device's EEPROM enables ID programming for optimum production and service flexibility **(Fig. 2)**. The device, with integrates control and Tx functions, supports both ASK and frequency-shift-keying (FSK) transmit modulation formats for further flexibility. It meets extreme TPM operation temperature conditions up to +125°C combined with lowest possible current consumption of 0.4 µA in sleep mode supported by the unique power-down modes of the 4-b Atmel microcontroller. The silicon bipolar Tx achieves +10-dBm maximum output power and beneficial spurious emission parameters of –52 dBm. It is also available in a pin-compatible flash version.

In addition, Atmel's T5753/52 PLL Tx IC is available in an eight-pin TSSOP8 package for all direct-sensing TPM frequency ranges. The PLL, which is well suited for used with a single-ended antenna, provides frequency stability and accuracy at UHF when operating with a low-cost crystal resonator; it requires only seven additional external components. The Tx is flexible enough to operate with voltages from +2 to +4 VDC; a version for use at +1.9 VDC is also available. MRF



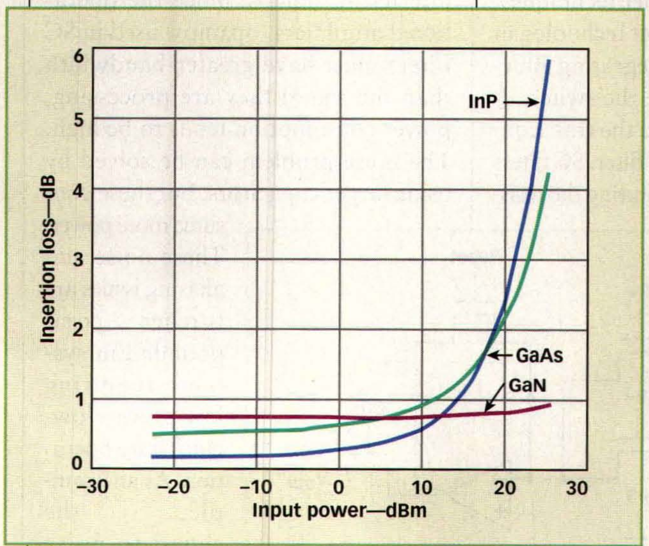
9. Power-dependent HEMT switch isolation is shown for a variety of temperatures at a characteristic impedance of 50 Ω, frequency of 1 GHz, and gate voltage of +1 VDC.

Continued from p. 60

power above +5 dBm for both the InP- and GaAs-based HEMT switches and above +15 dBm for the GaN-based HEMT switch. Figure 8 shows that the on-state capacitance varies with increasing input power above +15 dBm for the GaN-based HEMT switch, and no degradation of this capacitance was observed for inputs to +25 dBm for the two other technologies.

Figures 9 and 10 show the variations of shunt-connected HEMT isolation and series-connected HEMT insertion loss, respectively, with input power for the three technologies at 1 GHz. The effect of input power isolation and insertion loss was evaluated under on-state biasing conditions of Vg = +1.0 VDC). For both the InP- and GaAs-based HEMT switch technologies, there are strong degradations of isolation and insertion loss with increasing level of input power above 0 and +3.5 dBm, respectively. Compared with the AlGaN/GaN HEMT switch, the same phenomenon occurs at power levels above +15 dBm due the wide bandgap of the GaN material. This result shows the feasibility of using AlGaN/GaN HEMTs for high-power microwave control.

Table 2 summarizes cutoff frequencies and breakdown voltages calculated by the relationship from ref. 6. These cutoff-frequency results are based on a gate periphery W = 200 μm and a gate bias voltage of –2 VDC (C_{OFF}) and +2 VDC (R_{ON}). MRF



10. Power-dependent HEMT switch insertion loss is shown for a variety of temperatures at 50 Ω, frequency of 1 GHz, and gate voltage of +1 VDC.

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Sampling IF Filters Fortify Bluetooth Designs

The sampling intermediate-frequency (IF) filter is a high-performance digital device that can bring increased yield to integrated Bluetooth receiver designs.

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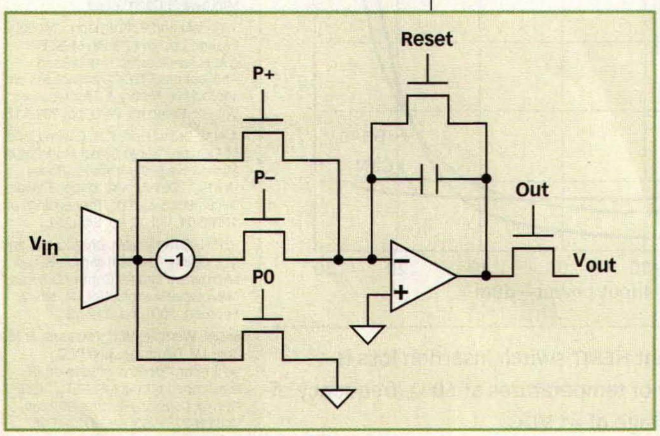
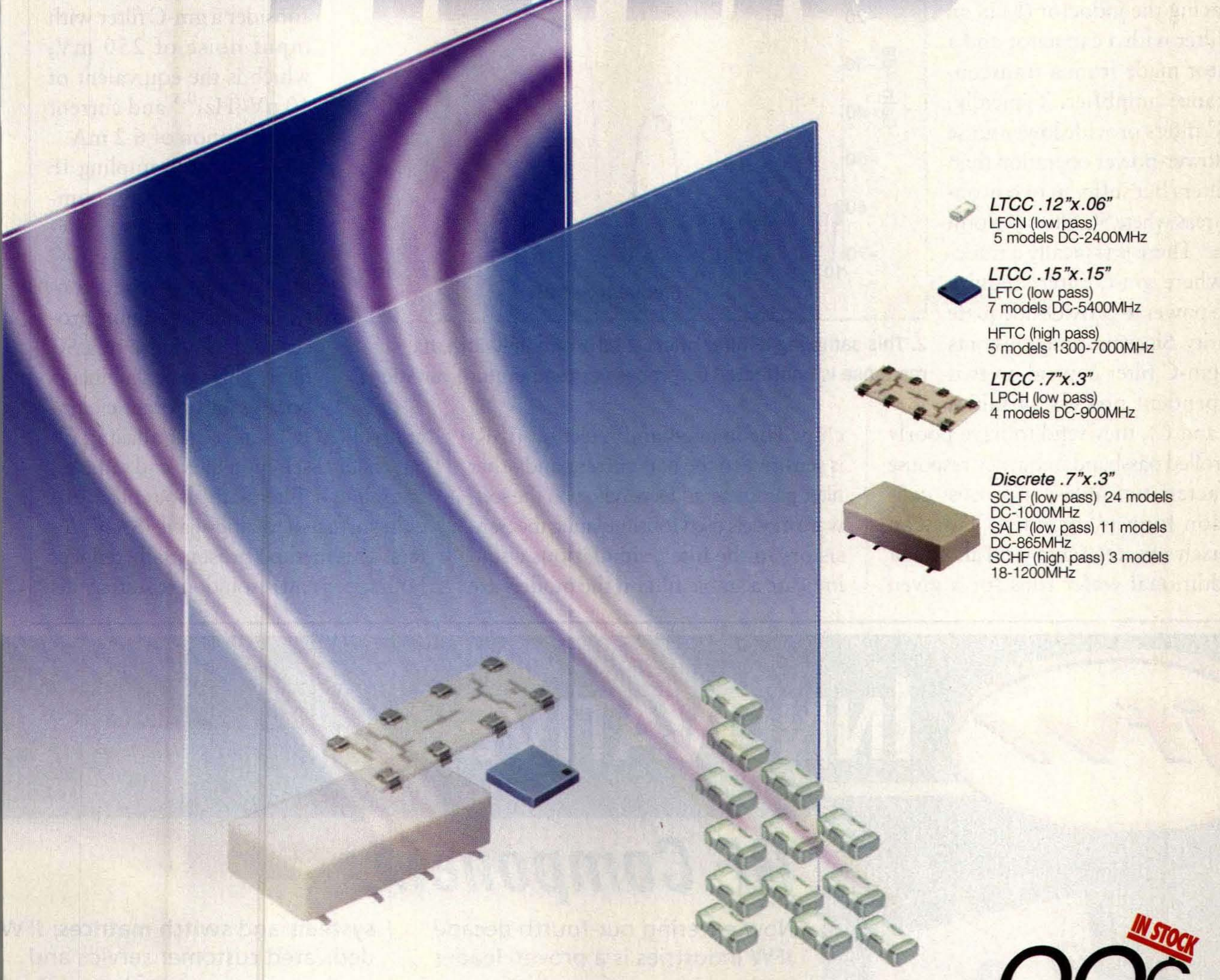
Bluetooth system architects strive to reduce cost, component count, and power consumption while maintaining high production yields for both chips and modules. Traditionally, the first three requirements are met by integrating off-chip components. However, a high level of analog integration adversely affects chip yield. Because of market demands for reduced cost and low component counts, Bluetooth is a prime example of a system-on-a-chip (SoC) technology reaching higher levels of integration. As an alternative low-power approach, it is possible to integrate intermediate-frequency (IF) filters in a Bluetooth receiver (Rx) for increased yield over other techniques.

Two well-known filter technologies have been used for integrating Bluetooth IF filters on chip: the switched-capacitor (SC) filter and the transconductor-capacitor (gm-C) filter. SC filters are constructed by substituting the resistors in an active RC filter with switches and capacitors. These SC filters have very precisely defined bandpass characteristics because the time constants associated with the frequency response depend only on the capacitor ratios and the clock frequency. A serious drawback with using SC filters in an IF stage is the danger of aliasing interfering signals. Since the operational amplifiers (opamps) used in SC filters must have greater bandwidth than the signal they are processing, power consumption tends to be high. The noise problem can be solved by using larger capacitors, but these consume more power. These noise and aliasing issues are further compounded in systems requiring low-power, low-clock-rate operation. As an example,[1] the signal-to-noise ratio (SNR) of one SC filter was 31 dB, which is the



1. This block diagram shows a single-ended version of a sampling IF filter, although the approach usually involves differential circuitry.

FILTERS



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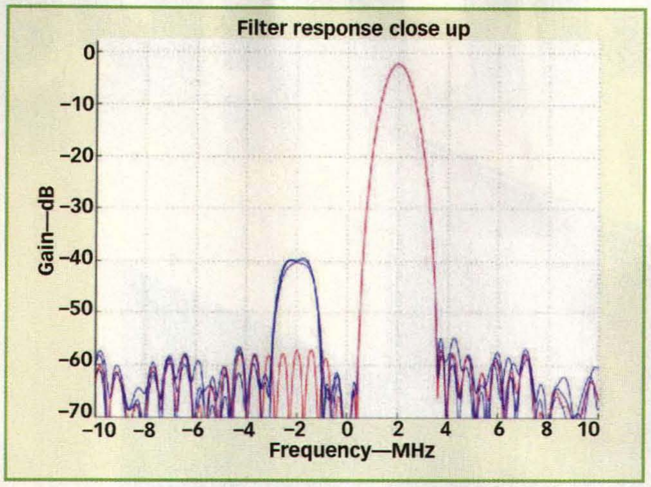
equivalent of 14 $nV/(Hz)^{0.5}$ and a current consumption of 10 mA.

A gm-C filter is constructed by replacing the inductor (L) in an LC filter with a capacitor and a gyrator made from a transconductance amplifier. Typically, gm-C filters provide lower noise and lower-power operation than SC filters but suffer in two problem areas where SC filters perform better. There is typically a tradeoff where gm-C filters require more power to provide adequate linearity. Since the time constants in a gm-C filter depend on two independent process variables (gm and C), they tend to have poorly controlled passband frequency response characteristics unless a process calibration loop is included. This can adversely effect the chip yield and result in additional wafer runs for a given chip. The image-band rejection (IBR) is sensitive to the bias current and other filter parameters.[2] Depending on the software models used for simulating the transistors in the filter, simulations could indicate a stable filter if the models are too simple. Once fabricated, the filters could still be unstable. As an example of this technology (see ref. 3), consider a gm-C filter with input noise of 250 mV, which is the equivalent of 10 $nV/(Hz)^{0.5}$ and current consumption of 6.2 mA.



2. This sampling IF filter offers 2 MHz of bandwidth. Its response is unaffected by process or temperature variations.

The new "sampling IF filter" technology, combines the low-power, low-noise properties of a gm-C filter with the precisely controlled passband and process independence of a SC filter. This single unit incorporates an automatic-gain-control (AGC) stage, anti-aliasing filter, channel-selection filter, and sampler. Sampling IF filters can also replace off-chip surface-acoustic-wave (SAW) filters. This method substantially reduces both speed and resolution requirements

specified for an analog-to-digital converter (ADC) because the channel-selection filtering is performed before the sampler and ADC. This saves power and allows the use of a simpler ADC.

Figure 1 shows a simplified circuit diagram of a sampling IF filter. Typically, this approach employs differential circuitry, although the diagram of Fig. 1 shows a single-ended version for simplicity. In a differential circuit, the –1 block can be implemented by crossing a pair of wires to invert the polarity of the current. To build finite-impulse-response (FIR) filters with an arbitrary sequence of tap coefficients whose values are 1, –1, or 0, the corresponding P+, P-, or P0, respectively, are set to be high at any one time. These quantized tap coefficients can be derived from an ideal FIR impulse response by delta-sigma (DS) quantization (ref. 4). Since the continuous-time input V_{in} is integrated continuously over the sample intervals, the filter has built in anti-aliasing.

Sampling IF filters can be designed for high RF image rejection without additional digital-correction techniques. In multimode radio applications, the sampling IF filter can be programmable, to eliminate several off-chip filters.

The sampling IF filter presented here represents a valuable breakthrough because superior in performance of both SC and gm-C filters. The sampling IF filter presented above consumes less power than an equivalent gm-C filter and is more stable than an equivalent SC filter.

Although the sampling IF filter approach can be applied to a variety of different systems, this presentation deals specifically with a sampling IF filter for an integrated Bluetooth Rx with a 13-MHz reference. The filter provides a 3-dB bandwidth of 480 kHz and out-of-band rejection of 50 dB for all undesired channels except the image frequency at –1 MHz (from the passband center frequency). For channels that are 3 MHz or more away from the desired channel, the filter provides at least 55-dB attenuation.

As an example, a filter was chosen with a 1-MHz sampling frequency with a 13-MHz option and a 2-MHz IF. The 13-MHz option allows initial 13-MHz sampling until the phase of the data clock is found and then switching to 1-MHz sampling to conserve power. Since the preamble of a Bluetooth packet is short compared to the length of a packet, the power savings for the filter and the downstream digital signal processor (DSP) can be substantial.

When designing a Bluetooth filter there is a trade-off between adjacent-channel interference (ACI) and ISI **(see table)**. Generally, as the filter band-

width narrows, the ISI increases; as the filter bandwidth increases, so does the ACI. ISI is also dependent upon the group delay of the filter. Because a sampling IF filter is a finite-impulse-response (FIR) filter, the group delay is a constant value. Therefore, it is possible to design a narrowband filter while maintaining low ISI. Referring again to Fig. 1, it is possible to design an ideal Bluetooth FIR filter with analog tap coefficients and then quantize these analog values to discrete digital values. These quantized digital values will then be applied to the P+, P-, or P0 inputs of the circuit.

Interference specifications for a 2-MHz Bluetooth IF

ACI FREQUENCY (absolute)(MHz)	ACI FREQUENCY OFFSET FROM CARRIER (MHz)	ACI AMPLITUDE COMPARED TO DESIRED SIGNAL (dB)
–1	–3	20
0	–2	30
1	–1	0
3	1	0
4	2	30
5	3	40

The channel-selection filter has a sufficiently narrow bandwidth to serve as an anti-aliasing filter as well. Obtaining this level of stop-band rejection close to the passband would typically require a seventh-order or higher filter.

There are two distinct disadvantages in using high-order multipole filters. They are very sensitive to process and temperature variations, so that chip yields will be low and iterations may be necessary to center the design. The other disadvantage is that each stage must be very linear to prevent intermodulation distortion (IMD). Conventional approaches to achieve this linearity typically require high power consumption.

In **Fig. 2**, the red line represents the response of the filter with no process or temperature variations included. The blue lines represent the effects of component mismatch and all other circuit and temperature variations. The filter exhibits almost 2 MHz of bandwidth.

A sampling IF filter also has the benefit of 48 dB of AGC. The filter's gain is adjustable in 30-dB steps by means of a 4-b control word. MRF

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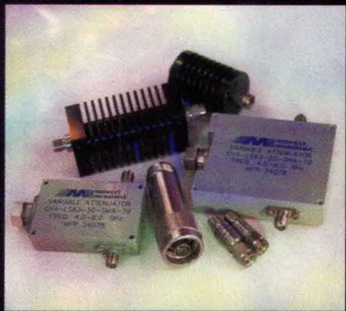
MIDWEST MICROWAVE

Attenuators



Fixed, Stepped, Continuously variable
Low VSWR, D.C. - 26.5 GHz, QPL

Terminations

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Short circuits, Low VSWR, D.C. - 26.5 GHz

D.C. Blocks

Inside/Outside, Inside Only
Rugged Construction

Couplers

Multi Couplers, Multi-Octave broadband
Hybrids, Octave bandwidth, D.C. - 18 GHz

Power Dividers

Broadband, Ultrabroadband, High Isolation
Low Phase & Amplitude Unbalance, D.C.-18 GHz

Equalizers

Broad or Narrow band, Fixed, Linear
Parabolic, Adjustable, D.C. - 18 GHz

Adapters

In - Series, Between Series, QPL
D.C. - 26.5 GHz

Cable Assemblies

Flexible, Phase Stable, Phase Matched
D.C. - 40 GHz

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Delay Lines, D.C. - 40 GHz

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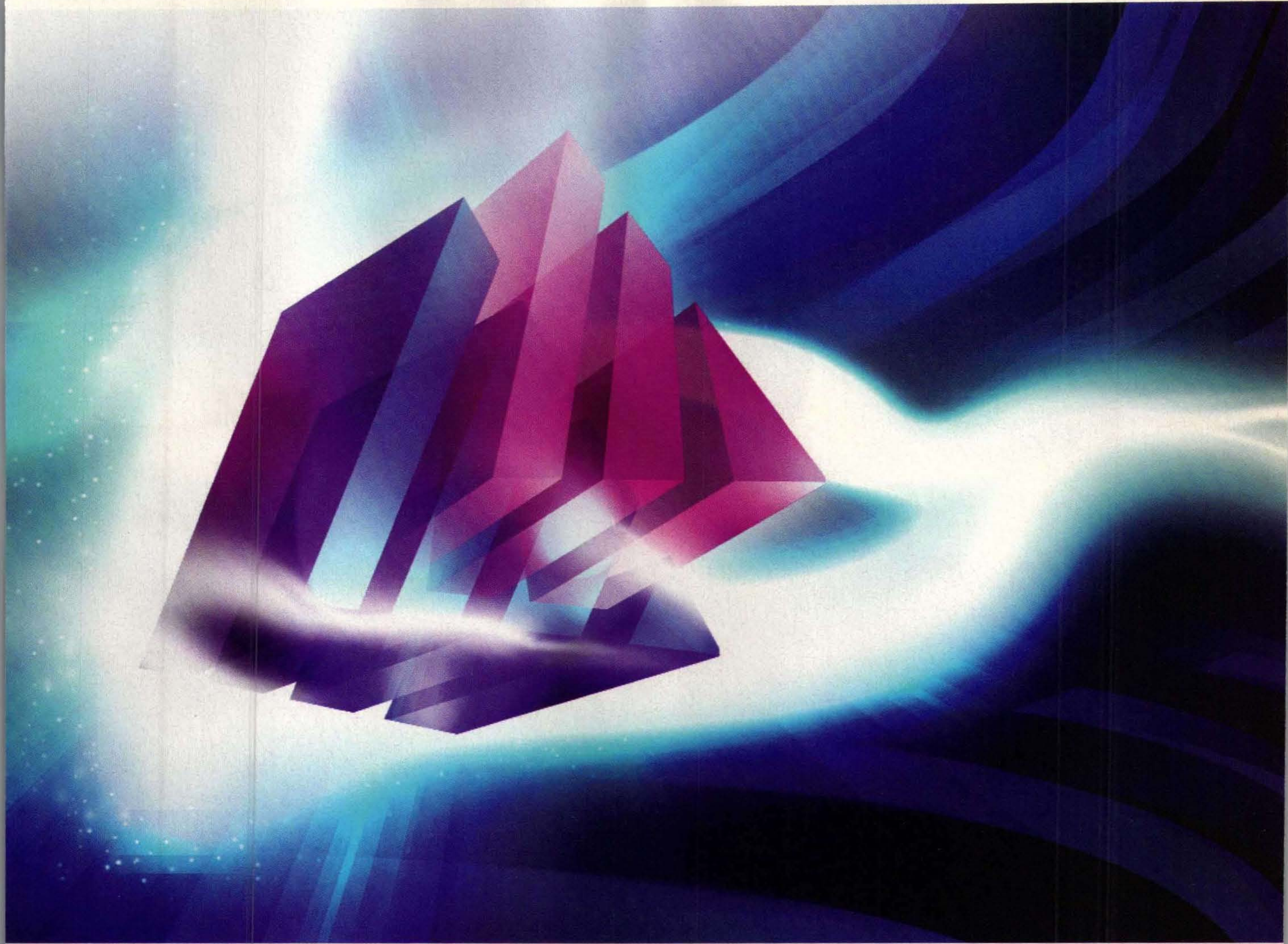
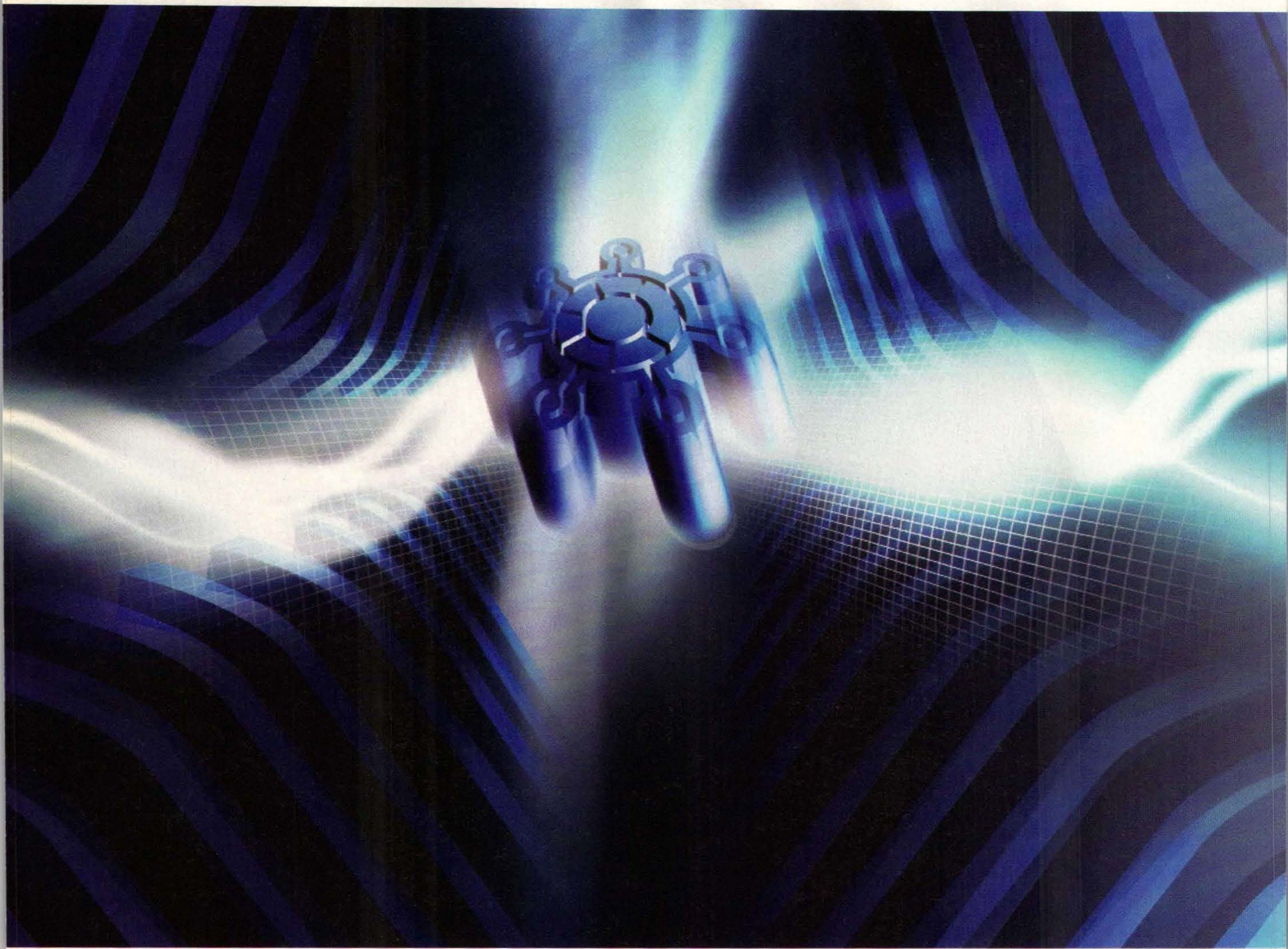




Making the most of microwave prescalers

MICROWAVE PRESCALERS are often used in frequency synthesizers and millimeter-wave frequency-conversion applications. For engineers seeking information on a high-performance line of prescalers for operation through 13 GHz, an application note from Hittite Microwave Corp. (Chelmsford, MA), simply titled "Microwave Prescalers," explores how to connect power-supply, input and output lines, and other circuits to a microwave prescaler for optimum performance.

The line of microwave prescalers detailed in the application note is fabricated with InGaP GaAs heterojunction-bipolar-transistor (HBT) device technology for low phase noise at microwave frequencies. At frequencies as high as 13 GHz, the single-sideband (SSB) phase noise is -145 dBc/Hz offset 100 kHz from the carrier. The prescalers are designed to operate from a single +5-VDC supply, although the note cautions that the voltage supply should be well conditioned in order to minimize degradation of prescaler phase noise. In addition to a 15-pF capacitor that is integrated into the prescaler, the note recommends a pair of external decoupling capacitors connected between the prescalers collected voltage terminal and ground, with capacitors placed as close to the collector voltage connection as possible.

Also to minimize noise, both of the prescaler's input lines should be DC blocked from the external circuitry. The capacitance and style of the DC blocking capacitors should be properly selected so that they do not cause significant attenuation of the input signal. The note provides guidance for both single-ended and differential input connections.

The note features useful advice on selecting optimal input and output signal levels, how to prevent prescaler self-oscillation, how to properly ground and heatsink a prescaler, and how to guard against degradation of phase-noise performance. In addition, the note includes an example 10.6-GHz phase-locked-loop (PLL) circuit for OC-192 fiber-optic communications applications. A free copy of the note can be downloaded from the company's website.

Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01842; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.

The note features useful advice on selecting optimal input and output signal levels, how to prevent prescaler self-oscillation, and how to properly ground and heatsink a prescaler.

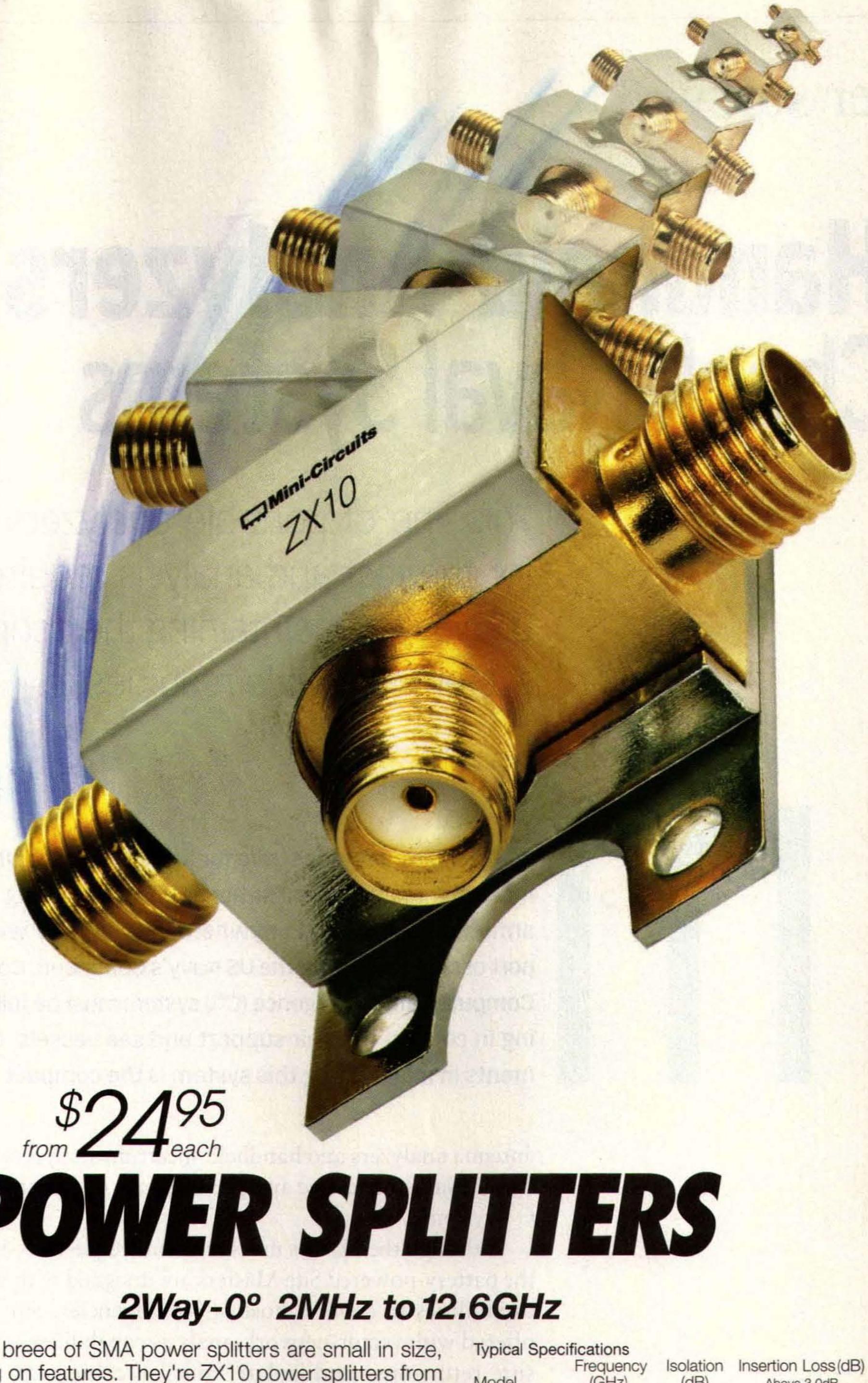
Circuit supports 5-GHz WLANs and UNII-band designs

STABLE AMPLIFICATION at 5.8 GHz is the goal of an application circuit developed by WJ Communications (San Jose, CA) as a demonstration of the company's low-cost packaged model A4 monolithic microwave field-effect-transistor (FET) amplifier. The application circuit, which operates from 5.725 and 5.825 GHz,, is ideal for fixed-wireless applications in the UNII band as well as for offset-frequency-division-multiplex (OFDM) wireless local-area networks at 5.8 GHz according to the IEEE 802.11a standard. The application circuit features 9.8-dB gain at 5.775 GHz with better than 10-dB output return loss, +28.1-dBm output power at 1-dB compression, and an output third-order intercept point of +42 dBm. By using the circuit in a balanced configuration, more than 1-W (+30 dBm) output power can be achieved.

The application note provides a full schematic diagram of the circuit, along with assembly details and test results for a finished version. The note recommends the use of an optional temperature-compensation active-bias circuit in order to stabilize performance over wide temperature ranges. This circuit requires two standard voltage supplies of +8 and –5 VDC. The temperature-compensation circuit uses dual PNP transistors to provide a constant drain current into the A4 FET. Temperature compensation is achieved by tracking the voltage variations with the temperature of the emitter-to-base junction of the PNP transistors. The transistor emitter voltage adjusts the voltage at the gate of the A4 FET so that the device draws constant current, regardless of the device's operating temperature.

In addition to the full amplifier schematic diagram, the application note includes a photograph of the layout along with a schematic diagram of the temperature-compensation circuitry. A free copy of the note can be downloaded from the company's website.

WJ Communications, 401, River Oaks Pkwy., San Joe, CA 95134-1916; (408) 577-6200, FAX: (408) 577-6621, e-mail: sales@wj.com, Internet: www.wj.com.


Mini-Circuits
ZX10

cover story

Handheld Analyzers Check Naval Systems

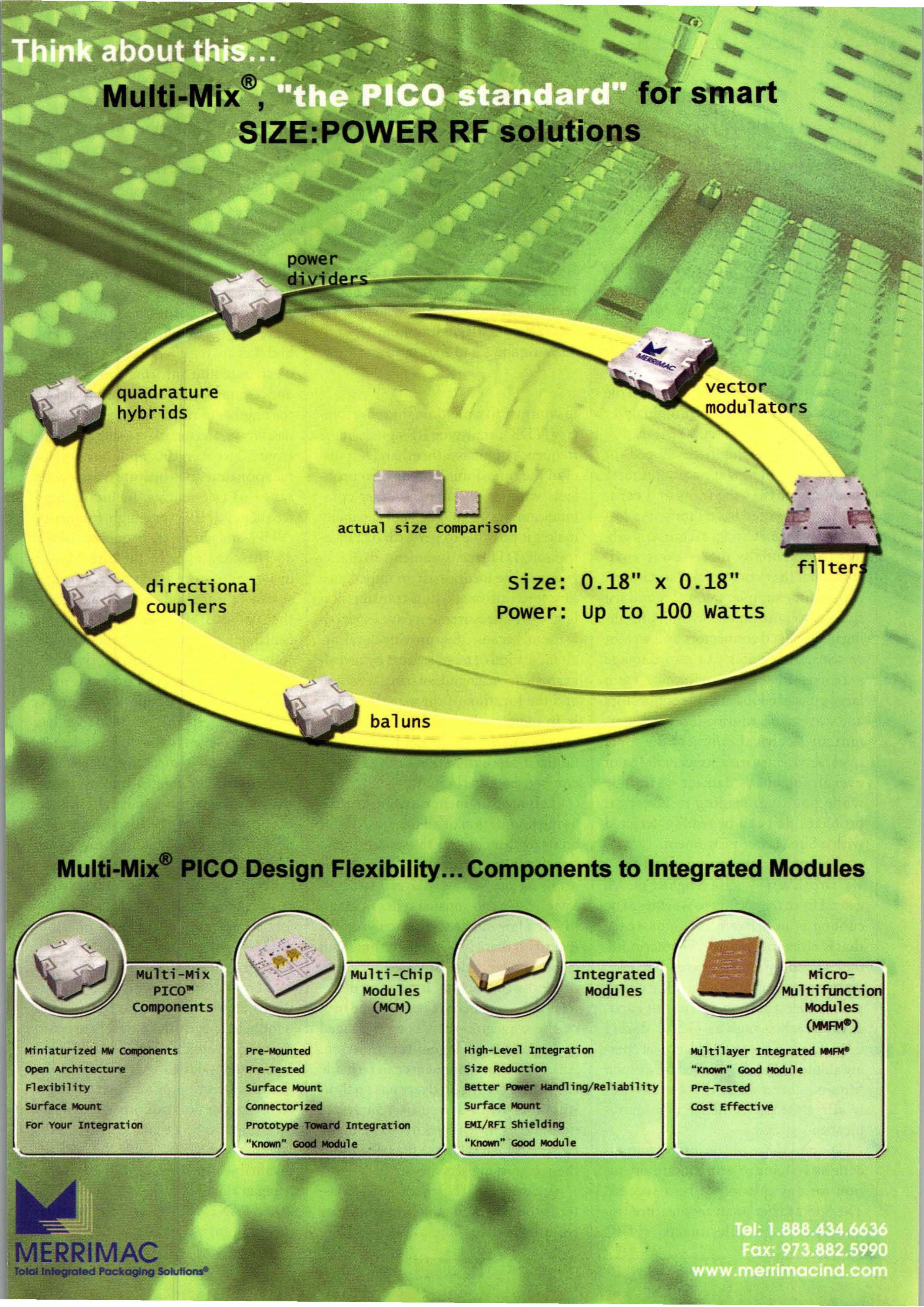
This line of portable analyzers is well suited for the test and analysis requirements of the US Navy in maintaining their sophisticated C^4I system for battle readiness.

modern military forces strive for agility and mobility, given the nature of modern threats. Current strategies plan on putting rapidly deployed small armed on the ground anywhere in the world within 96 hours. In support of such readiness, the US Navy's Command, Control, Communication, Computer, and Intelligence (C^4I) system must be fully functional and working in concert with air support and sea vessels. One of the key instruments in maintaining this system is the compact Site Master cable and
antenna analyzers and handheld spectrum analyzers from Anritsu Co., used by the Navy for service and performance diagnostics on their sophisticated C^4I systems.

Although the Navy's measurement frequencies of interest are classified, the battery-powered Site Masters are designed with wideband measurement capabilities to cover a host of contingencies. Site Masters are currently offered with vector-network-analysis capabilities—with the ability to measure return loss and isolate faults in cable runs between a transmitter (Tx)/receiver (Rx) and an antenna—as well as with spectrum-analysis capabilities (in order to view traditional plots of signal amplitude as a function of frequency). For example, the recently announced S810C and S820C Microwave Site Masters are vector-analyzer-based instruments with frequency spans of 3.3 to 10.5 GHz and 3.3 to 20 GHz, respectively **(see figure)**. Suitable for remote measurements of return loss and fault location, they feature a return-loss range of 0 to 54 dB with 0.01-dB resolution. These compact analyzers, which measure just 10 × 7 × 2.4 in. (25.4 × 17.78 × 60.96 cm) and weigh slightly more than 4 lbs. (1.8 kg), contain enough nonvolatile memory to store as many as 200 measurement traces.

In addition, model MS2711B is a portable spectrum analyzer with measurement range of 100 kHz to 3 GHz. It exhibits a noise level of better than −115 dBm and amplitude accuracy of ±2 dB. Weighing just under 5 lbs. (2.25 kg), the analyzer offers resolution-bandwidth filters of 10 kHz, 30 kHz, 100

YUENIE LAU
Product Marketing Manager
Anritsu Co., 490 Jarvis Dr., Morgan Hill, CA 95037-2908; (408) 778-2000, FAX: (408) 778-0239, Internet: www.us.anritsu.com.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kHz, and 1 MHz and video-bandwidth filters from 100 Hz to 300 kHz. The instrument has built-in amplitude-modulation (AM) and frequency-modulation (FM) demodulation capabilities, trace averaging, an RS-232C interface, and is well suited for both Tx and Rx measurements. Other Site Masters include the model S113C, with scalar-analysis capabilities from 2 to 1600 MHz, the model S114C, with spectrum-analysis capabilities over the same range, the model S331C, with scalar-analysis capabilities from 25 to 4000 MHz, and the model S332C, with spectrum-analyzer functions from 25 to 4000 MHz.

Although nominally developed for commercial wireless applications, these analyzers possess the traits and capabilities well suited for military wireless testing. Military testing, of course, is subject to potentially more severe environments that commercial situations. At sea, for example, salt water and sea spray can cause rapid corrosion, resulting in damaged connectors and weather seals. Salt water can also damage antennas. In addition, vibration from large guns can loosen cable connectors and waveguide, causing shorts or intermittent electrical contacts. In some cases, servicemen may accidentally paint over an antenna or damage waveguide while painting, leading to electrical problems that can be readily detected with a SiteMaster instrument.

Communications and electronic-warfare (EW) systems on fighter planes extend from the cockpit to wingtips. The cabling is in a fixed, confined space that is often inaccessible. Furthermore, these aircraft systems are exposed to wide discrepancies in temperature. For example, temperatures on an aircraft carrier can reach as high as +120°F during takeoff and –62°F when a plane is at cruising altitude. Vibration caused by weapon firing is another factor that can adversely affect the performance of communications systems.

Despite these obstacles, communications systems must maintain operation for any mission to be a success. The Site Master analyzers feature frequency-domain reflectometry (FDR)

The portable, battery-powered Site Master S810C and S820C instruments offer vector-network-analysis measurement capabilities at frequencies from 3.3 to 10.5 GHz and 3.3 to 20 GHz, respectively.

in contrast to time-domain reflectometry (TDR), analyzing RF signals in the frequency domain rather than DC pulses in the time domain to discern problems with an on-board military communications system. The FDR capability makes it possible to perform distance-to-fault (DTF) measurements to quickly detect the location of an impedance mismatch of break in a transmission line. DTF measurements are especially useful because they provide the clearest indication of trouble areas by revealing both the magnitude of signal reflection and the location of the signal anomaly. In addition, the analyzers provide 517 data points to enable identification of faults at more than twice the range of competitive offerings.

This measurement capability serves as the foundation of all the Site Master analyzers, including those developed specifically for the military. Technicians are using Site Master analyzers to determine a cable and antenna system's health in just a few minutes. The analyzer can identify if there is water in the antenna, cable damage, a defective weather seal, or a loose connection. It can even determine if the antenna has been painted over or the waveguide has been damaged and its effect on signal transmission. All of these measurements can be made easily because the analyzer has an intuitive and menu-driven user interface that allows measurements to be made by servicemen who are literally in on-the-job training scenarios.

Another crucial benefit of the Site Master is the patented superior immunity to interference. The analyzers have interference immunity of +17 dBm, which allows technicians to conduct analysis in the most complex and RF rich environments. This is especially important on a warship, which is part of a vast command, control, computer, and information network. Moreover, a Navy ship topside consists of a sophisticated assortment of weapons, electromagnetic (EM) radiators, and other hardware. A large number of antennas, Txs, and Rxs are required to meet the radar, electronic and information warfare, and communication requirements. In fact, the number of radiating systems (antennas, arrays, and radar) on a ship can range from 50 to over 100, and the communication antennas operate over a wide range of frequencies, including high frequency (HF), very-high frequency (VHF), and ultra-high frequency (UHF).

The capability of the Site Master analyzers to store as many as 200 measurement traces is beneficial as part of the Navy's PMS (Plan Maintenance Schedule), which requires maintenance to be performed on a quarterly basis. A technician can recall previous measurements taken of specific antennas to determine if the performance has degraded—even to the slightest degree.

When testing aircraft EW systems, the Site Master gauges amplitude levels over a wide dynamic range, from insertion loss as low as –90 dB to gain as high as 50 dB (160-dB dynamic range) with 0.1-dB resolution. This analysis capability is used to ensure that new or replacement cables match the loss for loss sensitive application or phase in phase-sensitive application. It is also used to determine overall system loss.

The lightweight, small size, and battery operation of the Site Master and handheld spectrum analyzers are also proving invaluable out at sea. When a technician is dangling 20 feet in the air at the tail section of a fighter plane or climbing a vertical ladder between decks on a ship, the fact that the instruments weigh about 5 lbs. (2.25 kg) proves invaluable. **Anritsu Co., 490 Jarvis Dr., Morgan Hill, CA 95037-2908; (408) 778-2000, FAX: (408) 778-0239, Internet: www.us.anritsu.com.**

MMIC Mixers Reach High Intercept Points

These high-dynamic-range monolithic mixers set new standards in third-order-intercept-point performance for cellular and PCS infrastructure applications.

NORM HILDRETH
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Dynamic range is a key requirement for the latest cellular and personal-communications-services (PCS) base stations. With growing complexity in digital modulation formats, and the use of dynamic power control, high-frequency mixers for these systems must deliver low noise and high third-order-intercept-point performance to meet even minimal dynamic-range requirements. Fortunately, the HMC399MS8, HMC400MS8, and HMC402MS8 monolithic-microwave-integrated-circuit (MMIC) mixers from Hittite Microwave (Chelmsford, MA) achieve third-order-intercept points (IP3s) to +36 dBm at cellular and PCS frequencies.

These passive gallium-arsenide field-effect-transistor (GaAs FET) MMIC mixers are ideal for Universal Mobile Telecommunications System (UMTS)-, code-division-multiple-access (CDMA)-, and Global System for Mobile Communications (GSM)-based systems. The low-cost mixers are supplied in plastic surface-mount eight-lead mini-small-outline-package (MSOP) housings and will satisfy a wide range of RF and intermediate-frequency (IF) plans for frequency upconversion or downconversion. At just 15 mm^2, the footprint of these new MSOP mixers is one-tenth the size of a typical hybrid mixer J-lead package footprint of 152 mm^2. The high input IP3 performance and output power at 1-dB compression rivals performance of traditional hybrid active FET mixers for an equivalent +17-dBm LO drive while requiring no DC bias supply.

Model HMC399MS8 operates over an RF range of 740 to 960 MHz, local-oscillator (LO) range of 540 to 900 MHz, and IF range of 60 to 250 MHz for GSM and CDMA applications. It provides IP3 performance to +35 dBm for downconversion and +32 dBm for upconversion. The mixer achieves as much as +23 dBm at 1-dB compression with 8.5-dB typical conversion loss and as much as 23 dB LO-to-

The high-IP3 mixers at a glance.

PARAMETER	HMC399MS8	HMC400MS8	HMC402MS8
RF range (GHz)	0.74 to 0.96	1.7 to 2.2	1.8 to 2.2
LO range (GHz)	0.54 to 0.9	1.4 to 2.15	1.85 to 2.53
IF range (MHz)	60 to 250	50 to 300	50 to 500
LO-to-RF isolation (dB)	25	33	30
Input IP3 (dBm)	+35	+36	+31

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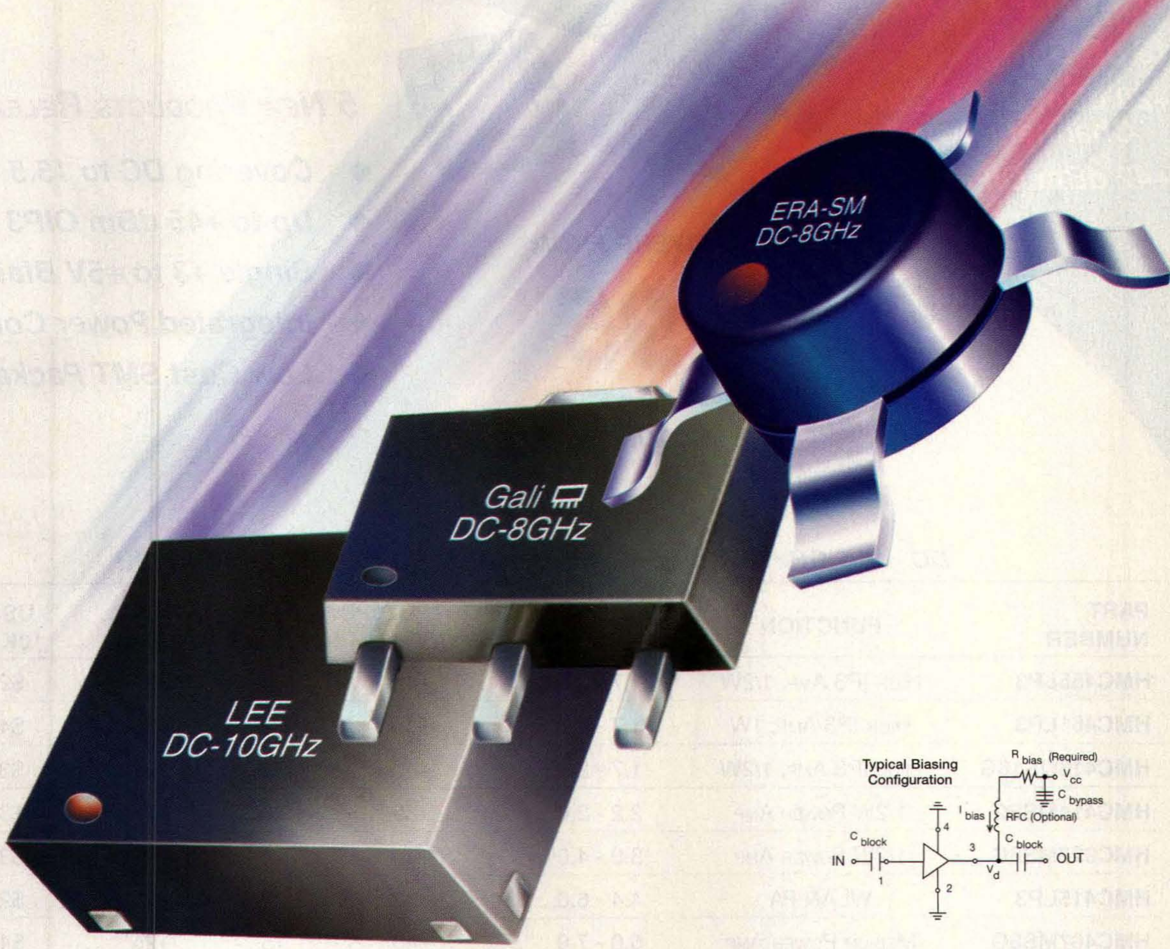

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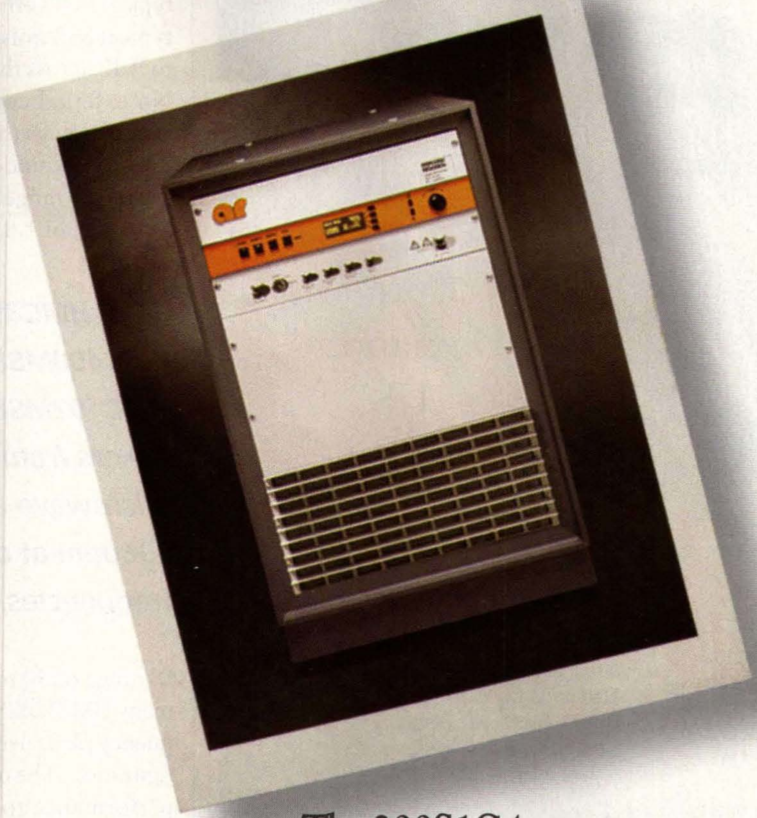


RF isolation and 27 dB typical LO-to-IF isolation **(see table)**. The single-sideband (SSB) noise figure is typically 9 dB over an RF range of 740 to 800 MHz, typically 8.5 dB for an RF range of 800 to 900 MHz, and typically 8 dB for an RF range of 880 to 960 MHz. The mixer requires only an external inductor and capacitor to optimize the LO frequency response.

Model HMC400MS8 covers an RF range of 1.7 to 2.2 GHz, LO range of 1.4 to 2.15 GHz, and IF range 50 to 300 MHz; it is suitable for most UMTS/PCS transmit or receive frequency plans configured with low-side LO architectures. This mixer offers excellent input IP3 performance to +36 dBm for downconversion to +31 dBm for upconversion. Rated for 1-dB compression of +21 dBm, the RF port can handle a wide range of input signal levels. The typical conversion loss is 8.8 dB while the typical LO-to-RF isolation is 33 dB and the typical LO-to-IF isolation is 23 dB. The typical SSB noise figure ranges from 8 to 9 dB across the full frequency range. No external components or bias are required with the HMC400MS8.

Finally, model HMC402MS8 covers an RF range of 1.8 to 2.2 GHz, an LO range of 1.85 to 2.53 GHz, and an IF range of 50 to 500 MHz, satisfying many UMTS/PCS transmit or receive frequency plans using a high-side LO configuration. The mixer features solid IP3 performance to +31 dBm for downconversion and to +27 dBm for upconversion. The 1-dB compression point is +21 dBm and the typical conversion loss is 8.5 dB. The typical SSB noise figure ranges from 8.5 to 8.8 dB across the full 1800-to-2200-MHz RF range. The HMC402MS8 exhibits 30 dB typical LO-to-RF isolation and 24 dB typical LO-to-IF isolation. As with the lower-frequency mixers, the HMC402MS8 does not require external components or a bias supply. All three mixers are 100-percent RF tested; all three are designed for nominal LO drive levels of +16 to +18 dBm. P&A: stock. **Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01842; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.**

The HMC399MS8, HMC400MS8, and HMC402MS8 MMIC mixers from Hittite Microwave achieve IP3s to +36dBm at cellular and PCS frequencies.

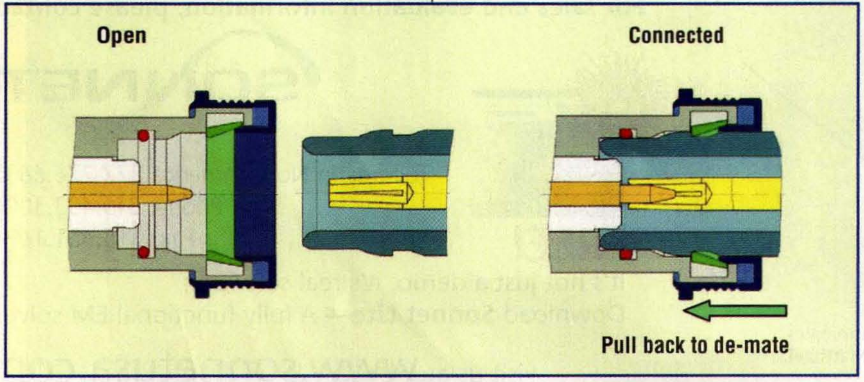
Coaxial Connector Is Type N Alternative

The excellent IMD performance and high-power-handling capability of these new connectors makes them ideal for the transmitter path in mobile radio base stations.

JACK BROWNE
Publisher/Editor

Coaxial connectors play a small but often critical role in communications systems. Since they are often an afterthought in the design of a complex system, poorly designed connectors can add to intermodulation-distortion (IMD) levels and become expensive items in loss budgets. Fortunately, the QN connector from Huber + Suhner (Essex, VT) offers the first practical alternative to Type N connectors in some time, capable of operating from DC to 11 GHz with low IMD and high power-handling capabilities.

The QN connectors **(see figure)** are optimized for use from DC to 6 GHz, but exhibit low loss through 11 GHz. They can be fitted on flexible and corrugated cables as well as on semirigid cables, and can handle power levels to 300 W CW at 2.5 GHz. The connectors achieve low levels of IMD, typically better than –155 dBc, making them well suited for use in the transmit path of mobile-radio base stations.



The QN connector features a simple snap-lock mechanism; connectors are de-mated by pulling back on the decoupling sleeve.

The quick connect/disconnect QN connector features a unique snap-lock design that is ideal for hand assembly, requiring about one-tenth the connector/cable assembly time of threaded Type N connectors. The QN connector's QuickLock mechanism employs a special spring-loaded contact element to ensure steady and uniform contact of the outer conductors; the spring force (and uniform contact) extends all the way around the face of the connector's bush contact.

The new QN connectors support higher package densities than conventional Type N connectors, since wrenches and other tools are not required for assembly (as well as the savings in additional tools).

The QN connectors feature full 360-deg. rotation of the plug to reduce stress on cable assemblies and eliminate the need for retightening hex nuts after installation. The QN connectors are available for use with cables and as panel-mount versions for use with enclosures and packaging. **Huber + Suhner, Inc., 19 Thompson Dr., Essex, VT 05452; (802) 878-0555, FAX: (802) 878-9880, Internet: www.hubersuhnerinc.com.**

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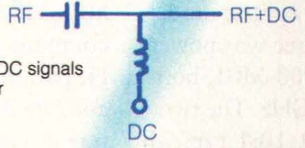

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With Mini-Circuits Bias-Tees, you can DC connect to the RF port of an active device without effecting its RF properties...modulate a laser, apply DC to an amplifier output, and more! Using statistical process control plus combining magnetics and microstrip, large DC currents may pass through the Bias-Tee without saturation and degradation of performance. At 1/3 to 1/4 the price of competitive units, these new Bias-Tees are available in surface mount, pin, and connectorized models. So why wait, solve your connection problems with Mini-Circuits Bias-Tees.

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Model	Freq (MHz)	Insertion Loss (dB Typ.)			Isolation (dB Typ.)			VSWR (Typ.)	Price $ ea
	F_L-F_U	L	M	U	L	M	U	U	1-9 qty.
▲ZFBT-4R2G	10-4200	0.15	0.6	0.6	32	40	50	1.13:1	59.95
▲ZFBT-6G	10-6000	0.15	0.6	1.0	32	40	30	1.13:1	79.95
▲ZFBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	50	1.13:1	79.95
▲ZFBT-6GW	0.1-6000	0.15	0.6	1.0	25	40	30	1.13:1	89.95
▲ZFBT-4R2G-FT	10-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	59.95
▲ZFBT-6G-FT	10-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-4R2GW-FT	0.1-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-6GW-FT	0.1-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	89.95
★ZNBT-60-1W	2.5-6000	0.2	0.6	1.6	75	45	35	1.35:1	82.95
■PBTC-1G	10-1000	0.15	0.3	0.3	27	33	30	1.10:1	25.95
■PBTC-3G	10-3000	0.15	0.3	1.0	27	30	35	1.60:1	35.95
■PBTC-1GW	0.1-1000	0.15	0.3	0.3	25	33	30	1.10:1	35.95
■PBTC-3GW	0.1-3000	0.15	0.3	1.0	25	30	35	1.60:1	46.95
•JEBT-4R2G	10-4200	0.15	0.6	0.6	32	40	40	-	39.95
•JEBT-6G	10-6000	0.15	0.7	1.3	32	40	40	-	59.95
•JEBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	40	-	59.95
•JEBT-6GW	0.1-6000	0.15	0.7	1.3	25	40	30	-	69.95

L = Low Range M = Mid Range U = Upper Range

NOTE: Isolation dB applies to DC to (RF) and DC to (RF+DC) ports.
▲SMA Models, FT Models Have Feedthrough Terminal ★Type N, BNC Female at DC
■Pin Models •Surface Mount Models

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Combiners/Dividers Range 0.8 To 3.0 GHz

These ruggedly built power splitters and combiners/dividers are designed to minimize losses and distortion when handling moderate to high power levels to 3 GHz.

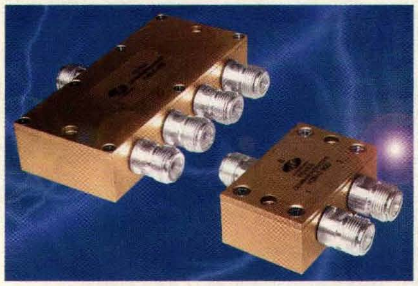
JACK BROWNE
Publisher/Editor

Power combiners/dividers are invaluable components when summing the contributions of multiple power amplifiers (PAs) or splitting signals into lower-power multiple signals. A line of power combiners/dividers from MECA Electronics (Denville, NJ) combine the traits most desirable in this type of component, including low insertion loss, low VSWR, good power-handling capabilities, and high isolation between channels. The components detailed here range in frequency from 0.8 to 3.0 GHz, making them applicable for all cellular, personal-communications-services (PCS) and wireless-local-area-network (WLAN) systems.

The broadest-frequency models include two-way power splitter model R2N-1.900-M01 and three-way power splitter model R3N-1.900-M01, both for use from 0.8 to 3.0 GHz. The two-way splitter features 1.10:1 typical VSWR and 1.20:1 maximum VSWR with 0.3 dB typical insertion loss. The amplitude imbalance is typically 0.1 dB. The worst-case phase imbalance is 2 deg. The two-way splitter handles RF input power levels to 200 W.

Three-way power splitter model R3N-1.900-M01 exhibits typical VSWR of 1.15:1. The typical insertion loss is 0.3 dB. The amplitude imbalance is typically 0.1 dB with worst-case performance of 0.2 dB. The maximum phase imbalance is 3 deg. The three-way power splitter also handles input levels as high as 200 W. Both the two- and three-way power splitters measure 5.25 × 1.00 × 0.81 in. (13.34 × 2.54 × 2.1 cm) and are supplied with Type N female connectors. The connectors are constructed with silver-plated brass to minimize passive intermodulation distortion (PID) in wireless communications systems. The splitters are rated for operating temperatures from –55 to +85°C.

At lower frequencies, in cases where high port-to-port isolation is desired, the company offers the two-way model H2N-0.900 power combiner/divider and the four-way model H4N-0.900 power combiner/divider, both from applications from 0.8 to 1.0 GHz **(see figure)**. The two-way component features typical VSWR of 1.10:1 with typical insertion loss of 0.2 dB. The worst-case amplitude imbalance is 0.1 dB while the worst-case phase imbalance is 2 deg. Isolation between ports is at least 20 dB. The combiner/divider handles a total of 100 W RF power, or 25 W maximum per port. **MECA Electronics, Inc., 459 East Main St., Denville, NJ 07834; (866) 444-MECA, (973) 625-0661, FAX: (973) 625-1258, e-mail: sales@e-meca.com, Internet: www.e-meca.com.**



The four-way model H4N-0.900 power combiner/divider (left) and the two-way model H2N-0.900 power combiner/divider (right) are designed for use from 0.8 to 1.0 GHz.

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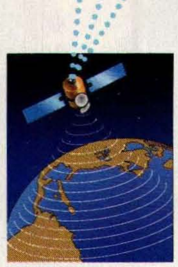


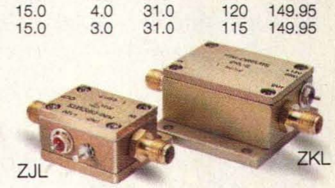
From amateur radio to cellular to satellite applications, with medium output power up to 17dBm, Mini-Circuits versatile ZJL and ZKL connectorized amplifiers offer the broad range of choices designers demand for achieving high system performance goals. Ultra-wideband models deliver **gain ranging from 9 to 40dB** and IP3 up to +32dBm. But beyond the performance and reliability built into these miniature 12V amplifiers lies another important feature, the low price...from only $99.95! Call now for fast delivery.

Mini-Circuits...we're redefining what VALUE is all about!

SPECIFICATIONS

Model	Freq (MHz)	Gain (typ) Midband (dB)	Gain (typ) Flat (±dB)	Max. P_{out}1 (dBm)	Dynamic Range (Typ @2GHz[2]) NF(dB)	Dynamic Range (Typ @2GHz[2]) IP3(dBm)	I(mA)[3]	Price $ea. (1-9)
ZJL-5G	20-5000	9.0	±0.55	15.0	8.5	32.0	80	129.95
ZJL-7G	20-7000	10.0	±1.0	8.0	5.0	24.0	50	99.95
ZJL-4G	20-4000	12.4	±0.25	13.5	5.5	30.5	75	129.95
ZJL-6G	20-6000	13.0	±1.6	9.0	4.5	24.0	50	114.95
ZJL-4HG	20-4000	17.0	±1.5	15.0	4.5	30.5	75	129.95
ZJL-3G	20-3000	19.0	±2.2	8.0	3.8	22.0	45	114.95
ZKL-2R7	10-2700	24.0	±0.7	13.0	5.0	30.0	120	149.95
ZKL-2R5	10-2500	30.0	±1.5	15.0	5.0	31.0	120	149.95
ZKL-2	10-2000	33.5	±1.0	15.0	4.0	31.0	120	149.95
ZKL-1R5	10-1500	40.0	±1.2	15.0	3.0	31.0	115	149.95

NOTES:
1. Typical at 1dB compression.
2. ZKL dynamic range specified at 1GHz.
3. All units at 12V DC.



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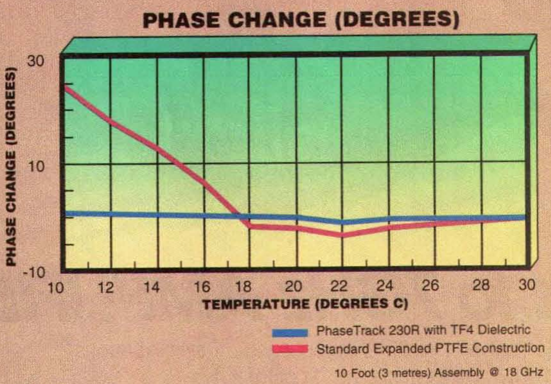

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A LOW-COST PLANAR antenna is available in standard or custom frequencies from 300 to 900 MHz to meet worldwide frequency allocations. The "Splatch" utilizes a proprietary grounded-line technique to extract good performance from a tiny surface-mount element. Unlike many compact antennas, the "Splatch" is highly immune to proximity effects, making it suitable to handheld applications such

as remote controls, pagers, and alert devices. The antenna's SMD package is appropriate for reflow or hand attachment. The antenna measures 1.1 × 0.5 × 0.062 in. (2.8 × 1.27 × 0.157 cm) and exhibits a 50-Ω characteristic impedance and a VSWR of less than 1.9. P&A: Less than $1.00 in production quantities.

Antenna Factor, 575 SE Ashley Pl., Grants Pass, OR 97526; (541) 956-0931, FAX: (541) 471-6251, Internet: www.antennafactor.com.

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A PAIR OF HIGH output IP3 GaAs InGaP HBT MMIC amplifiers cover applications from 1.7 to 2.5 GHz. The HMC455LP3 and HMC461LP3 amplifiers are suited for a variety of PCS/3G wireless infrastructure applications offering +19 and +20 dBm WCDMA channel output power respectively at –45 dBc ACP. The 0.5-W HMC455LP3 provides 13 dB of gain and +28 dBm of saturated power at 56 percent PAE from a single +5-VDC supply voltage. This MMIC amplifier uses a minimum number of external components, has high output IP3 of +42 dBm, and low VSWR of 1.4:1. The 1-W HMC461LP3 offers the linear performance of two HMC455LP3s in a single IC yielding an output IP3 of +45 dBm. It can be configured in a balanced or push-pull amplifier circuit providing 12 dB of gain and +30.5 dBm of saturated power at 48 percent PAE from a single +5-VDC supply voltage. Both amplifiers are packaged in low-cost, leadless QFN 3 × 3-mm surface-mount packages. P&A: Sample and production quantities are available.

Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01824; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.

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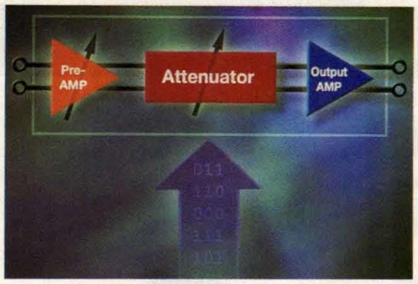
THE AD8370 IS A high-linearity, fully differential, digitally controlled, variable-gain amplifier (VGA) designed for use in wireless and wired communication networks. The AD8370 provides a 700-MHz bandwidth (–3 dB), enabling the part to be used at intermediate frequencies (IFs) up to 380 MHz. The AD8370 enables designers to select between two gain-control ranges (a high-gain mode adjustable from +6 to +34 dB and a low-gain adjustable from –11 to 17 dB) through a 3-b serial interface. P&A: Samples and pre-production quantities are available for immediate shipment. The AD8370 is priced at $4.20 per unit in 1000-piece quantities.



Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; (781) 329-4700, FAX: (781) 326-8703, Internet: www.analog.com.

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WAVE-ENABLED SOFTWARE FOR the advanced analysis of printed-circuit boards (PCBs), components, and packages addresses the rigorous demands placed on high-speed designers. SIwave is the only signal-integrity tool on the market to allow both frequency- and time-domain results to be generated from a physical description of the device, allowing engineers to model not only individual components, but also entire PCBs and package structures.

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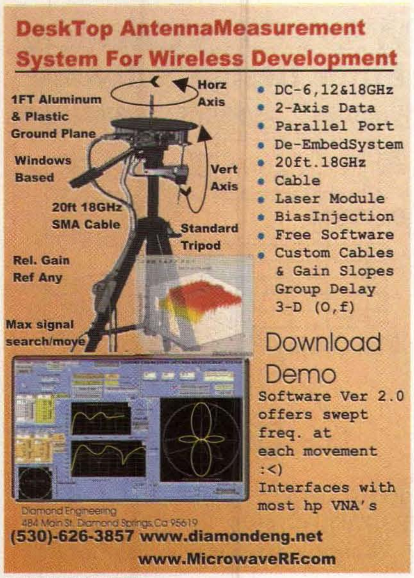

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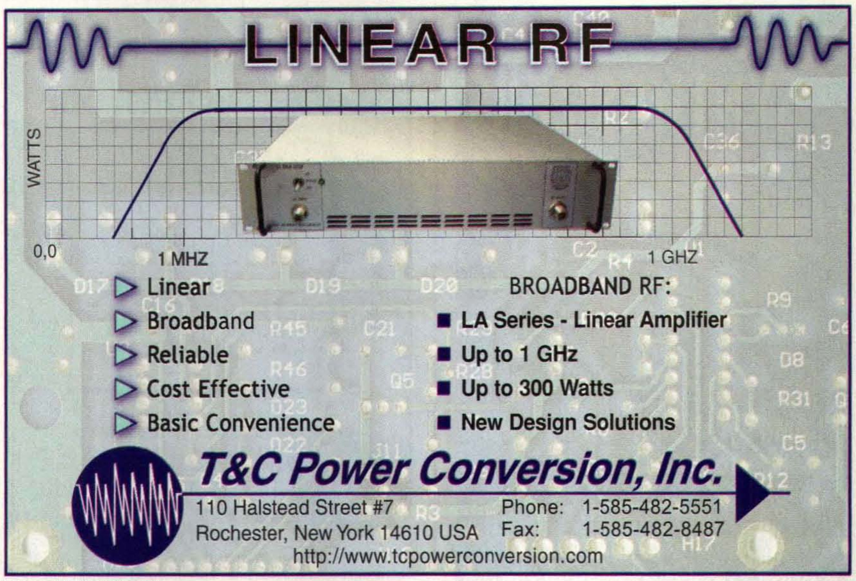

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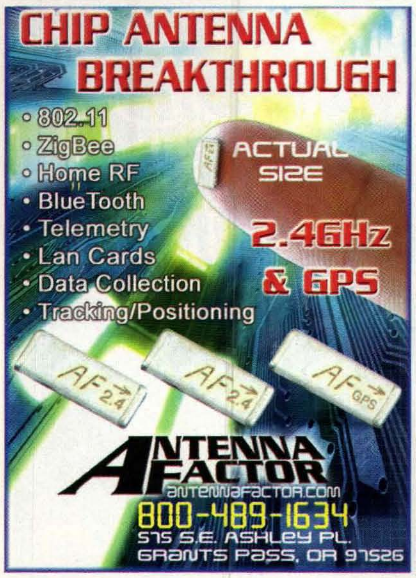

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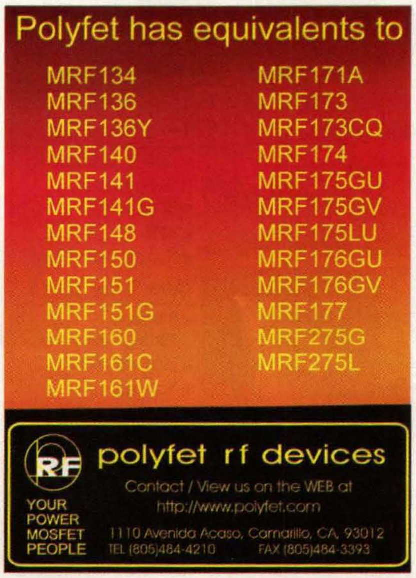

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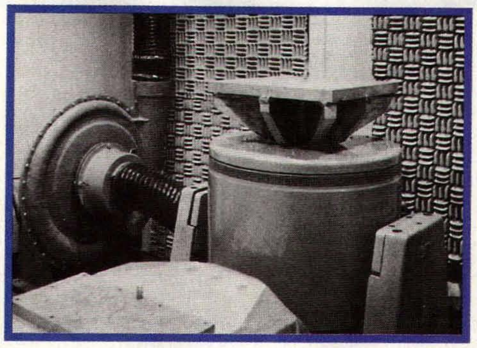

ALMOST 21 YEARS AGO, a report on the small-but-innovative firm RHG Electronics (Deer Park, NY) highlighted the company's in-house capabilities in vibration testing according to MIL-STD-810 and STD-202 guidelines.

next month

Microwaves & RF April Editorial Preview

Issue Theme: Wireless Technology

News

Attendance at the recent Wireless Systems Design Conference & Expo (San Jose, CA) was strong and visitors were enthusiastic about upcoming wireless business prospects for the remainder of 2003. Some of the key market opportunities, including in Bluetooth and WLANs, were not surprises. But a number of companies revealed designs targeting embedded GPS applications and large potential markets in automotive telematics applications. Don't miss this exclusive wrap-up of key products and technologies from the February 2003 wireless show.

Design Features

Design Features in April cover various aspects of wireless design and simulation. An author from Motorola, for example, explores ways for integrating EDA tools with load-pull measurements, while an author from Agilent Technologies will compare measurement methods for evaluating the equivalent-series resistance (ESR) of capacitors and inductors. Additional technical articles in April will reveal techniques for constructing gain-slope equalizers for millimeter-wave amplifiers, highlight measurement methods for checking the performance of high-power amplifiers with the burst waveforms commonly found in many modern communications systems, and detail the design of a packet-division-multiple-access (PDMA) receiver for wireless Internet applications.

Product Technology

In April, the Product Technology section will road test a new line of wafer probes designed for testing high-frequency silicon-based IC technologies, such as SiGe. The probes achieve low contact resistance by means of lithographically defined thin-film contacts on a multilayer polyimide membrane. Also in April, a well-known supplier of trimmer capacitors unveils a new line of VCXOs, while additional stories describe an innovative blind-mate connector, a novel analog circuit that improves the distortion (dynamic-range) characteristics of power amplifiers, and a unique millimeter-wave Grid amplifier technology capable of achieving tube-like power from semiconductor amplifiers.